Anderson Serangoon Junior College
2021 Preliminary Examination
H2 Chemistry Paper 1 Suggested Worked Solution

1 Two particles, $\mathbf{A}^+$ and $\mathbf{B}^{3+}$ are fired with equal velocity into an electric field.

The information on two particles are given in the table below.

particle	number of electrons	number of neutrons	angle of deflection in an electric field
$\mathbf{A}^+$	10	12	2.0°
$\mathbf{B}^{3+}$	?	14	5.1°

What is the number of electrons for $\mathbf{B}^{3+}$?

A 10 **B** 11 **C** 12 **D** 13

Answer: A

	e	p	n (given)	Mass (n+ p)	Charge, q	$\frac{q}{m}$	θ (given)
$\mathbf{A}^+$	10	10+1 = 11	12	23	+1	$\frac{1}{23}$	2.0°
$\mathbf{B}^{3+}$	?	?	14	m	+3	$\frac{3}{m}$	5.1°

By proportion,

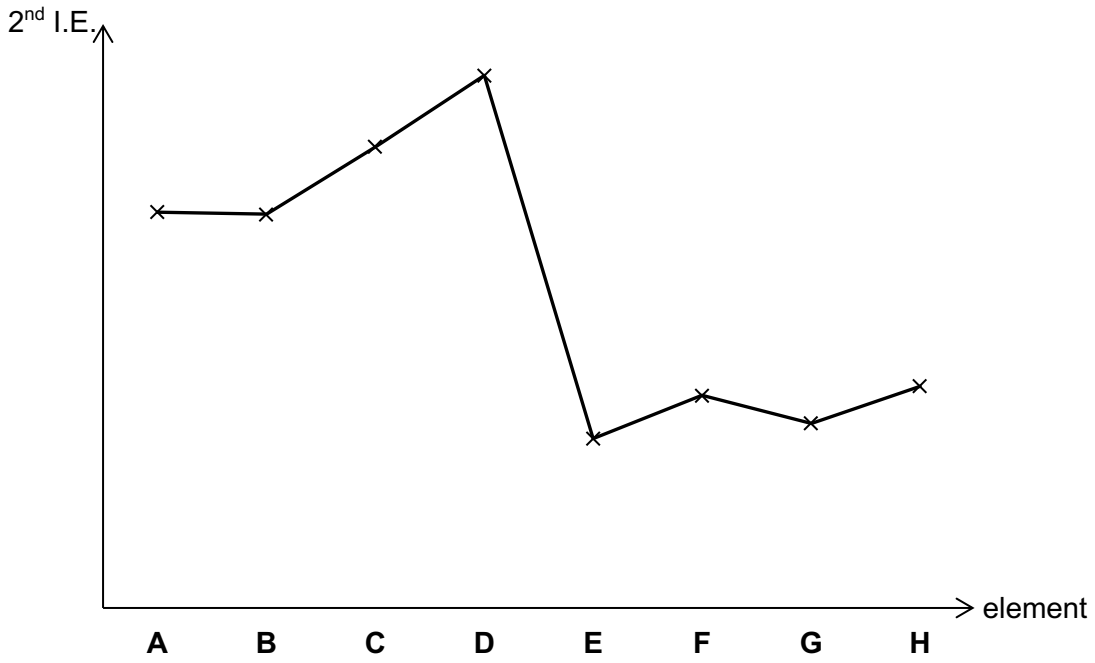
$\frac{q}{m}$ for $\mathbf{B}^{3+}$ = $\frac{1}{23} \div 2 \times 5.1 = 0.1109$

$\therefore \frac{3}{m} = 0.1109$

$m = \mathbf{27}$

Number of protons for $\mathbf{B}^{3+}$ = 27 -14 =13
Number of electrons for $\mathbf{B}^{3+}$ = 13-3 = **10**

2 **A** to **H** are consecutive elements with atomic numbers less than 20. The graph below shows their second ionisation energies (2^{nd} I.E.).



Which of the following statements is correct?

A The 2^{nd} IE of **G** is lower than that of **F** due to the inter-electronic repulsion between its paired s electrons.

B **C** exists as diatomic molecules at room temperature.

C The compound formed between **A** and **E** has a low melting point.

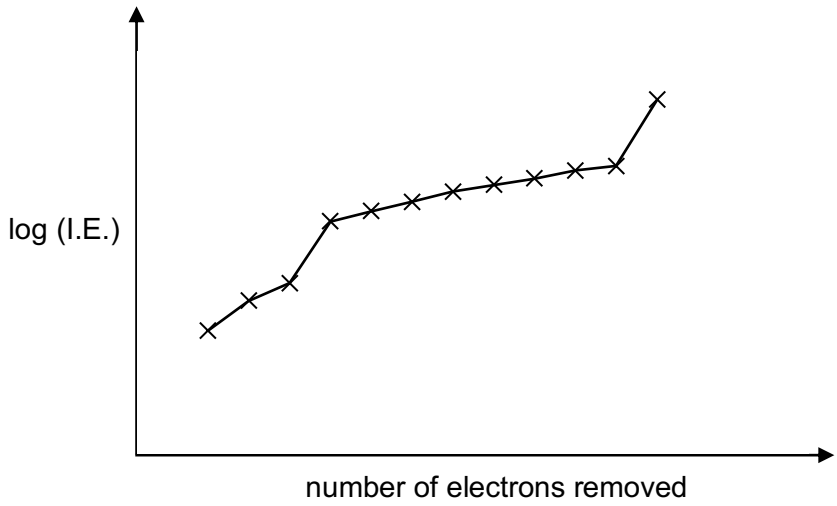
D Element **B** is from Group 17.

Answer: D

Since there is sharp decrease in 2^{nd} IE between elements D & E, the electron removed from $E^+(g)$ is in an electron shell that is further from the nucleus than that from $D^+(g)$.

D^+ has noble gas configuration. D has 1 valence electron, hence it is from Group 1. Counting backwards, B is from Group 17.

3 The graph shows the logarithm of the first twelve ionisation energies (I.E.) for element **J.**



What can be deduced about element **J** from the graph?

1 It can form a compound with oxygen with the formula $\mathbf{J}_2O_3$.

2 **J** is likely to have a lower first I.E. than the element preceding it in the same period.

3 It is in the second period (Li to Ne) of the Periodic Table.

4 **J** has a half-filled p-subshell.

A 1, 2 and 3

B 1, 2 and 4

C 1 and 2 only

D 3 and 4 only

Answer: C

1 **Correct**
Element **J** belongs to Group 13.
Largest energy difference between the 3rd and 4th I.E. This implies that the removal of the 4th electron is from an inner quantum shell which requires more energy.
Hence, element **J** has **3 valence electrons** and can form a compound with oxygen with the formula $\mathbf{J}_2O_3$.

2 **Correct**
Valence electronic configuration for **J**: $ns^2\ np^1$
Valence electronic configuration for element preceding **J**: ns^2
The first ionisation energy for element **J** requires removing 1 electron from **p** subshell which is further from the nucleus than s subshell and experience weaker electrostatic attraction.
Hence, the first I.E of **J** is lower than the element preceding it in the same period.

3 **Incorrect**
Period 2 elements have a maximum of only 10 ionisations energies but element **J** has at least twelve ionisation energies.

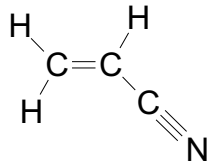
4 **Incorrect**
Valence electronic configuration for **J**: $ns^2\ np^1$
Element **J** does not have a half-filled p-subshell.

4 Acrylonitrile, CH_2=CHCN is a monomer used to made polyacrylonitrile.

Which row correctly describes the ~~bonding~~ number of π bonds and hybridisation in a molecule of acrylonitrile?

	Number of π bonds	Number of sp C atoms	Number of sp^2 C atoms
A	2	2	1
B	3	1	2
C	1	1	2
D	1	2	1

Answer: B



Double bond consists of 1 σ and 1 π. Triple bond consists of 1 σ and 2 π.
Total no. of π bond = 1 + 2 = 3
The nitrile group has 1 sp C atom. The alkene has 2 sp^2 C atoms.

5 The mechanism for a certain reaction is given below.

step 1 $(CH_3)_3\mathbf{C}OH + HCl \xrightarrow{\text{fast}} (CH_3)_3\mathbf{C}\overset{+}{O}H_2 + Cl^-$

step 2 $(CH_3)_3\mathbf{C}\overset{+}{O}H_2 \xrightarrow{\text{slow}} (CH_3)_3\overset{+}{\mathbf{C}} + H_2O$

step 3 $(CH_3)_3\overset{+}{\mathbf{C}} + Cl^- \xrightarrow{\text{fast}} (CH_3)_3\mathbf{C}Cl$

Which of the statements are correct?

1 There is a decrease in the bond angle with respect to O atom in step 1.

2 The shape with respect to C atom in bold, changes from tetrahedral to trigonal planar and back to tetrahedral in the mechanism.

3 Dative bond is formed in step 1 and 3.

A 1 and 3

B 1 and 2 only

C 2 and 3 only

D 2 only

Answer: C

Statement 1 is incorrect.

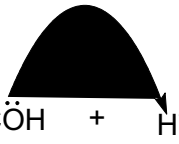
O in reactant has 2 bond pairs and 2 lone pairs with bond angle 104.5°. It has increases to 3 bond pairs and 1 lone pair with bond angle 107° in the product.

MCQ Tip ☺: Since option 1 is wrong, you can remove option A and B. Thus, all you have to do is to analyse option 3 to decide on the option to pick.

Statement 2 is correct.

Step	reactant	product
1	4 bp tetrahedral	4 bp tetrahedral
2	4 bp tetrahedral	3 bp only Trigonal planar
3	3 bp only Trigonal planar	4 bp tetrahedral

Statement 3 is correct.



step 1 $(CH_3)_3C\ddot{O}H + H^+ \longrightarrow (CH_3)_3C\overset{+}{O}H_2$

Lone pair from O atom donates to empty orbital in H^+.

step 3 $(CH_3)_3\overset{+}{C} + :Cl^- \longrightarrow (CH_3)_3CCl$

Lone pair from Cl^- donates to empty orbital in positively charged C of carbocation.

6 In which of the following does Statement **II** give a correct explanation for Statement **I**?

	Statement **I**	Statement **II**
1	Magnesium has a higher melting point than sodium.	Magnesium has more delocalised valence electrons which results in stronger metallic bonds.
2	Glycine, H_2NCH_2COOH, has a higher melting point than 2–hydroxyethanoic acid, $HOCH_2COOH$.	Glycine can form more extensive hydrogen bonds than 2–hydroxyethanoic acid.
3	Chloromethane undergoes nucleophilic substitution more easily than fluoromethane.	The C–C*l* bond in chloromethane is weaker than the C–F bond in fluoromethane.

A 2 and 3 only

B 1 and 2 only

C 1 and 3 only

D 1, 2, and 3

Answer: C

Statement 2 is incorrect.
Glycine forms zwitterions and has an ionic lattice structure with strong electrostatic forces of attraction between the zwitterions, hence has a higher melting point than 2–hydroxyethanoic acid

7 The amount of carbon monoxide present in air can be determined by its reaction with iodine pentoxide, I_2O_5, to form carbon dioxide and iodine in the reaction below.

$$5CO + I_2O_5 \rightarrow I_2 + 5CO_2$$

The amount of iodine liberated is then determined by titration with a standard solution of sodium thiosulfate.

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$$

A 100 cm^3 sample of polluted air is passed over solid iodine pentoxide and the iodine produced required 20.0 cm^3 of 0.20 mol dm^{-3} of sodium thiosulfate for complete reaction.

What is the concentration, in g dm^{-3}, of carbon monoxide present in the sample of polluted air?

A 0.100

B 1.12

C 2.80

D 11.2

Answer: C

$5CO + I_2O_5 \rightarrow I_2 + 5CO$
$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$

$5CO \equiv I_2 \equiv 2S_2O_3^{2-}$

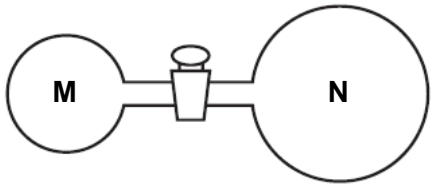
$nS_2O_3^{2-} = \frac{20}{1000} \times 0.2 = 0.004$ mol

$nCO = \frac{5}{2} \times 0.004 = 0.01$ mol

Mass of CO = 0.01 x (12 + 16) = 0.28 g

Concentration of CO = $\frac{0.28}{\frac{100}{1000}}$ = **2.80 g dm^{-3}**

8 Two glass vessels **M** and **N** are connected by a closed valve.



M contains helium at 25 °C at a pressure of 1 x 10^5 Pa. **N** has been evacuated, and has three times the volume of **M**. In an experiment, the valve is opened and the whole set-up placed in boiling water at 100 °C.

What is the final pressure in the system?

A 3.13 × 10^4 Pa
B 3.76 × 10^4 Pa
C 1.00 × 10^5 Pa
D 1.33 × 10^5 Pa

Answer: A

Let the volume of M be v, hence volume of N is 3v. Total volume = 4v

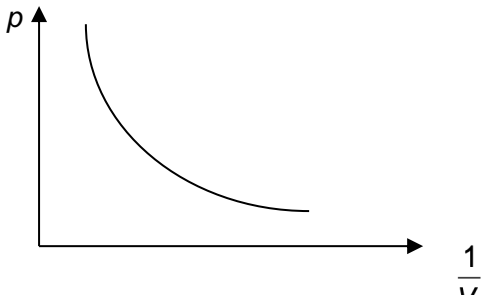
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{10^5 \times v}{298} = \frac{P_2 \times 4v}{373}$$

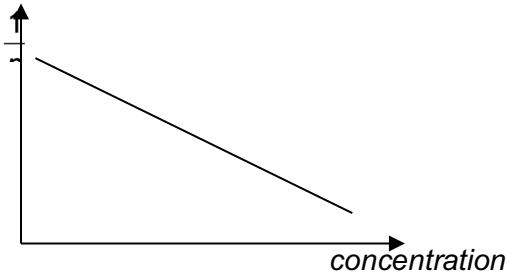
P_2 = 3.13 x 10^4 Pa

9 Which of the following diagrams correctly describes the behavior of a fixed mass of an ideal gas at constant *T*?

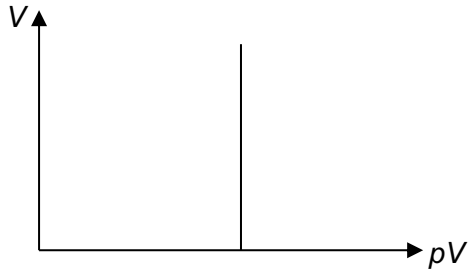
A



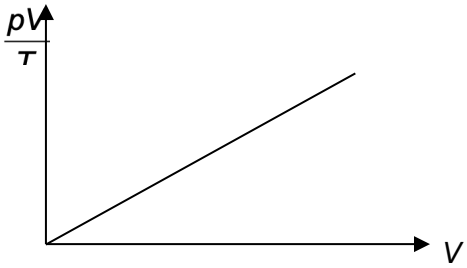
B



C



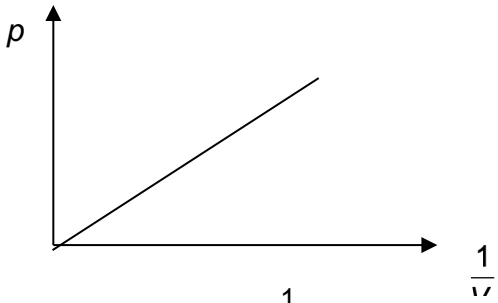
D



Answer: C

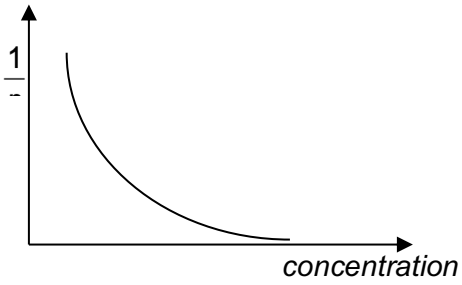
The correct diagrams are as follow. Note that n and T are constant in all cases.

A



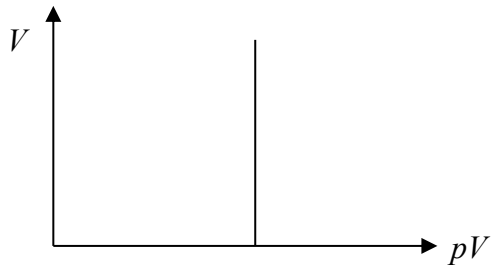
$pV = nRT \rightarrow p = nRT(\frac{1}{V})$

B



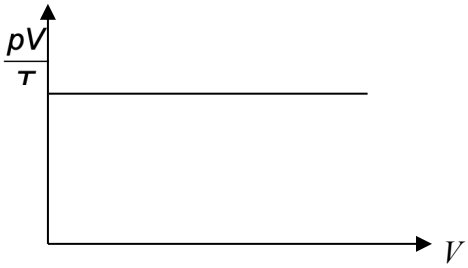
$pV = nRT \rightarrow p = (\frac{n}{V})RT \rightarrow p = cRT$

C



$pV = nRT$ (pV is a constant)

D



$pV = nRT \rightarrow \frac{pV}{T} = nR$ (constant)

10 30 cm^3 of 0.1 mol dm^{-3} of sulfuric acid and 40 cm^3 of 0.2 mol dm^{-3} sodium hydroxide were mixed in a styrofoam cup.

Assume that the density and specific heat capacity of the final mixture are 1.0 g cm^{-3} and 4.2 J g^{-1} K^{-1} respectively.

What is the temperature change for the reaction given that the standard enthalpy change of neutralisation is −57.3 kJ mol^{-1}?

A −1.6 °C **B** −1.2 °C **C** +1.2 °C **D** +1.6 °C

Answer: C

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$n(H_2SO_4) = \frac{30}{1000} \times 0.1 = 0.003$ mol

$n(NaOH) = \frac{40}{1000} \times 0.2 = 0.008$ mol

H_2SO_4 is the limiting reagent.

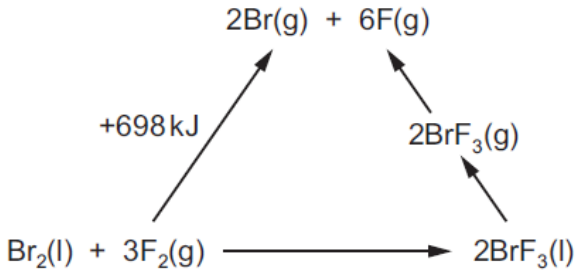
$n(H_2O) = 2 \times n(H_2SO_4)$
$= 2 \times 0.003$
$= 0.006$ mol

Heat released from the reaction = $n(H_2O) \times \Delta H_{neu}$
$= 0.006 \times 57.3 \times 1000$
$= 343.8$ J
= heat absorbed by the solution

heat absorbed by the solution = $mc\Delta T$
$343.8 = 70 \times 1 \times 4.2 \times \Delta T$
$\Delta T = 1.2$ °C

Since the reaction is exothermic, ΔT = **+ 1.2 °C**.

11 An energy cycle is drawn for the following reaction.



The standard enthalpy of formation of $BrF_3(l)$ = –301 kJ mol^{-1}.

The enthalpy change of $BrF_3(l)$ to $BrF_3(g)$ is + 44 kJ mol^{-1}.

What is the average bond energy of the Br-F bond in BrF_3?

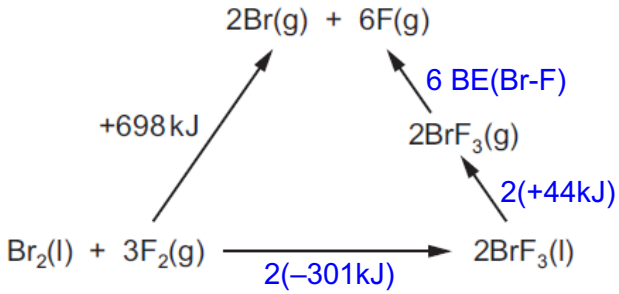
A 152 kJ mol^{-1}

B 159 kJ mol^{-1}

C 202 kJ mol^{-1}

D 404 kJ mol^{-1}

Answer: C



By Hess's Law
698 = (-301 x 2) + (44 x 2) + 6 BE(Br-F)
BE(Br-F) = 202 kJ mol^{-1}

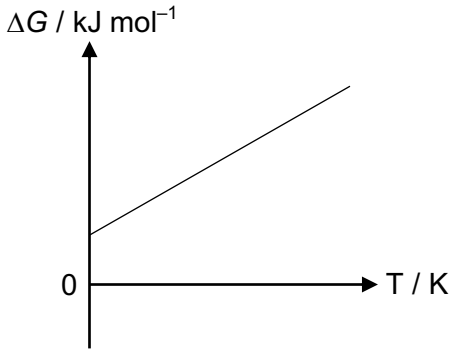
12 Methanol can be synthesised from carbon monoxide and hydrogen according to the equation.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

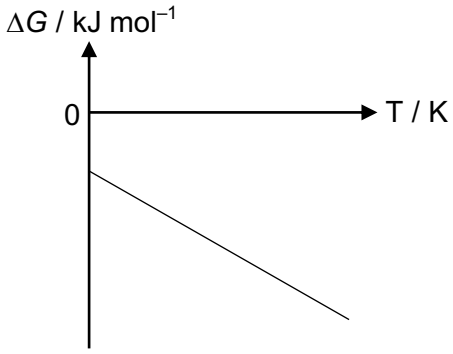
Higher yield of methanol can be achieved at a lower temperature.

Which graph corresponds to the forward process?

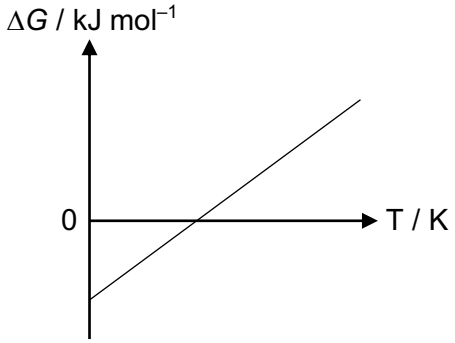
A



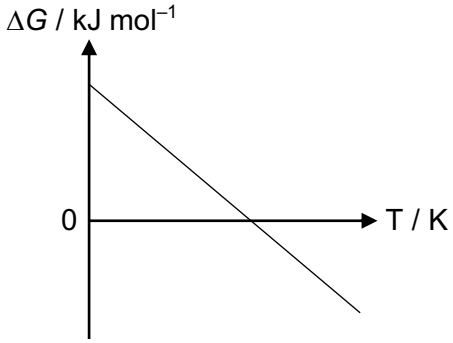
B



C



D



Answer: C

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

For the forward reaction, ΔS is negative as there is a decrease in the number of moles of gaseous molecules (resulting in a less disordered system).

ΔH is negative as "higher yield of methanol can be achieved at a lower temperature." That is, at lower temperature, position of equilibrium is shifted to the right, favouring an exothermic reaction.

$\Delta G = \Delta H - T\Delta S$
ΔH is the y-axis intercept and since it is an exothermic reaction, it is negative

At T=0 K, $\Delta G = \Delta H$
ΔG is negative.

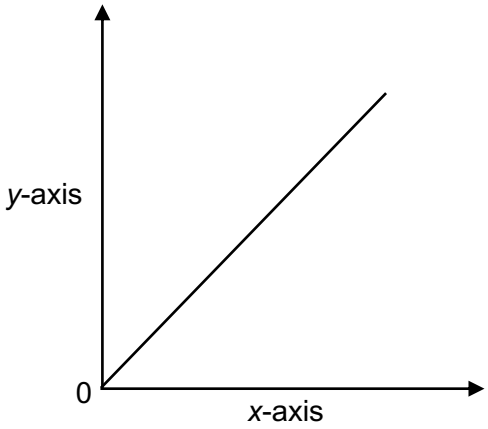
Gradient is $-\Delta S$. Since ΔS is negative, gradient is positive.

13 The kinetics of the following reaction is investigated under different conditions. The reaction is first order with respect to **G**.

$$\mathbf{G} \longrightarrow \mathbf{H}$$

The table shows pairs of quantities that were plotted as graphs.

Which pairs gave the following graph?



	y-axis	*x*-axis
1	rate	concentration of **G**
2	half-life of **G**	rate constant
3	concentration of **H**	time

A 1 and 2 only

B 1 only

C 2 and 3 only

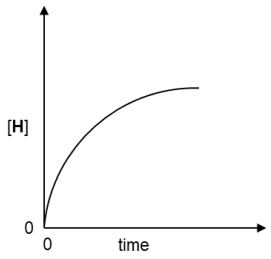
D 1 and 3 only

Answer: B

Since the reaction is first order with respect to **G**, the rate equation can be written as rate = k[**G**]. Hence plotting the rate against concentration of **G** will give an upward slopping straight line passing through 0 as shown in the question. Hence 1 is correct.

If half-life of G is plot against rate constant, using $t_{1/2} = \frac{\ln 2}{k}$ it will correspond to a $y = \frac{1}{x}$ graph.

Since the reaction is first order with respect to **G**, the rate of reaction decreases as the reaction proceeds due to the decreasing concentration of **G**. Plotting the concentration of **H** (product) against time, will give an upward slopping curve with a decreasing gradient. The decreasing gradient indicates a slower rate as the reaction proceeds.



Hence, 3 is incorrect.

14 The ionic product of water, K_w, is affected by temperature.

temperature / °C	K_w / mol^2 dm^{-6}
0	1.15×10^{-15}
25	1.00×10^{-14}
50	5.50×10^{-14}

What can be deduced from this information?

A Only at 25 ºC are $[H^+]$ and $[OH^-]$ equal.

B The equilibrium lies more to the left as temperature increases.

C The $[H^+]$ increases while the $[OH^-]$ decreases as temperature increases.

D The pH of water at 50 °C is 6.6.

Answer: D

$[H^+] = [OH^-]$ for all temperature thus (A) is wrong.

When temperature increases K_w increases. This implies position of equilibrium shifts towards right (B) favouring forward endothermic reaction to absorb heat. $[H^+]$ and $[OH^-]$ increases to the same extent (C).

$[OH^-] = [H^+] = \sqrt{5.50 \times 10^{-14}} = 2.345 \times 10^{-7} \text{ moldm}^{-3}$

pH = $-\lg(2.345 \times 10^{-7}) = 6.6$

15 Which of the following reactions is the underlined reactant acting as a Bronsted-Lowry base?

1 $\underline{NH_3} + CH_3Cl \rightarrow CH_3NH_3^+ + Cl^-$

2 $\underline{OH^-} + HSO_4^- \rightarrow H_2O + SO_4^{2-}$

3 $\underline{CH_3OH} + HClO_4 \rightarrow CH_3OH_2^+ + ClO_4^-$

4 $\underline{HNO_3} + H_2SO_4 \rightarrow H_2NO_3^+ + HSO_4^-$

A All the above.

B 1 and 2 only.

C 1 and 3 only.

D 2, 3 and 4 only

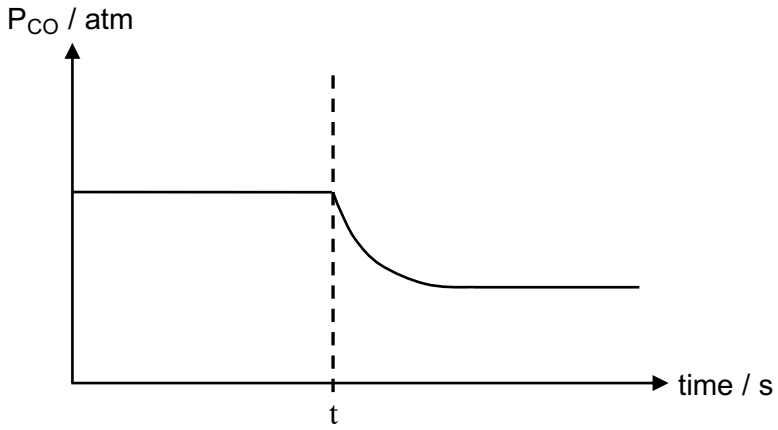
Answer: D

1	NH_3 is acting as a nucleophile and is not accepting H^+.
2, 3 and 4	The formulae of products from reaction of OH^-, CH_3OH and HNO_3 differs by H^+. This implies OH^-, CH_3OH and HNO_3 accepted a H^+ hence acting as a Bronsted-Lowry base.

16 A sealed vessel of fixed volume contains the following mixture at equilibrium.

$$H_2O(g) + C(s) \rightleftharpoons H_2(g) + CO(g) \qquad \Delta H > 0$$

At time t, the reaction mixture is subjected to a change. The graph below shows the partial pressure of CO against time.



Which changes, when carried out separately, could have given the graph above?

1 addition of $H_2(g)$

2 removal of some C(s)

3 decrease in temperature

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 3 only

Answer: C

K_c (and K_p) expression of heterogeneous equilibrium exclude the concentration (or partial pressure) of pure solids and pure liquids because they are constant at a given temperature. Hence, the removal of some solid carbon will not change its concentration and has no effect on the position of equilibrium. ⇒ Statement 2 is incorrect

Addition of $H_2(g)$ and a decrease in temperature will cause the position of equilibrium to shift to the left, lowering the partial pressure of CO(g).
⇒ Statements 1 and 3 are correct

17 For the elements in the third period of the Periodic Table, which property decreases consistently from sodium to chlorine?

A melting point

B ionisation energy

C electrical conductivity

D radius of the atom

Answer: D
Statement A is wrong as Si has the highest melting point
Statement B is wrong as I.E. data fluctuate across the period
Statement C is wrong as electrical conductivity increase from Na^+ to Al^{3+} before decreasing.

Source: Nov 2013 P1 Q13

18 Which property generally increases down Group 2?

A sum of the first and second ionisation energies

B reactivity of metal with cold water

C polarising power of the cation

D oxidising power of the cation

Answer: B

E° (M^{2+}/M) more negative down the group. M is more easily oxidised, ie reactivity increases.

The size of the metal cation increases down the group, leading to a decrease in their charge density and polarising power.

Valence electrons are removed from an outershell that is further away from the nucleus. Sum of IE decreases as it is easier to remove the valence electrons due to weaker attraction with between nucleus and valence electron.

19 *Use of the Data Booklet is relevant to this question.*

Two separate half-cells are connected and the following reaction was observed.

$$2I^-(aq) + H_2O_2(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

Which statements about this cell are true?

1 E^θ_{cell} = +1.23 V.

2 E_{cell} becomes more negative when $Br_2(aq)$ is added to the anode.

3 E_{cell} becomes more positive when H_2O is added to the cathode.

A 1 only

B 1 and 2

C 2 and 3

D 1, 2 and 3

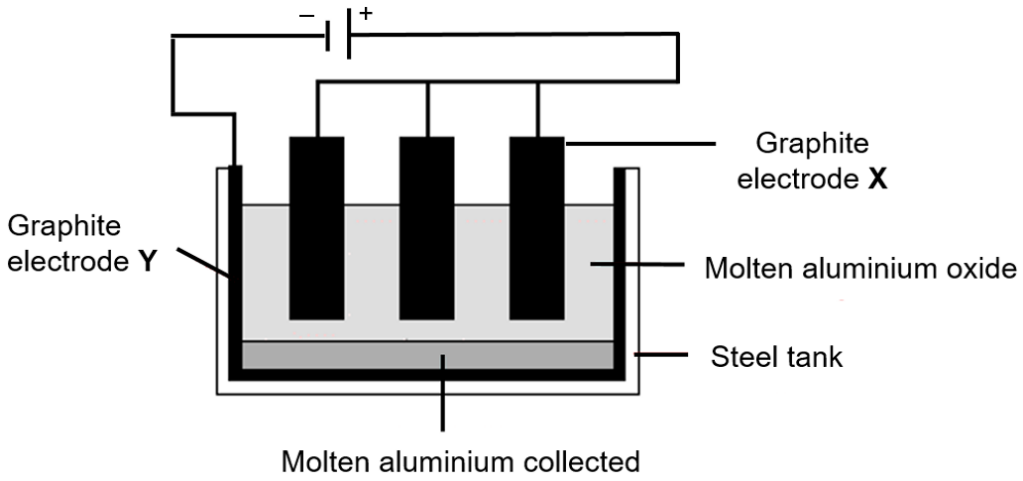
Answer: B

Statement 1 is true: E^θ_{cell} = (+1.77) – (+0.54) = +1.23 V

Statement 2 is true: $Br_2(aq)$ added will remove I^- causing $E^\theta_{oxidation}$ of I^- to be more positive which will cause E^θ_{cell} becomes less positive.

Statement 3 is false: Addition of water to the H_2O_2 half cell will shift the equilibrium position to the left, $E^\theta_{reduction}$ becomes less positive which cause E^θ_{cell} becomes less positive.

20 Aluminium is extracted from its ore by electrolysis.



Which of the following statements is correct?

1 Oxygen gas is produced.

2 Aluminium ions migrate to electrode **X**.

3 Electrons move from electrode **X** to electrode **Y** via the external circuit.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1 only

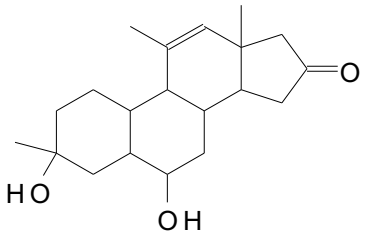
Answer: B

Option 1 is correct.
Electrode **X** is the positive electrode i.e. the anode, anions (i.e. O^{2-}) migrate here and oxidation takes place. O^{2-} is oxidised to $O_2(g)$.

Option **2** is incorrect.
Electrode **Y** is the negative electrode i.e. the cathode, cations (i.e. $A/^{3+}$) migrate here and reduction takes place.

Option **3** is correct
Electrons move from negative terminal of the battery to electrode **Y,** and electrode **X** to the positive terminal of the battery. Thus, electrons move from electrode **X** to electrode **Y.**

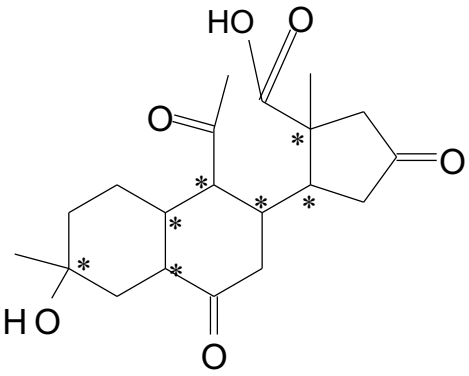
21 How many possible enantiomers can be obtained when the following compound is heated with excess acidified $KMnO_4$?



A 7 **B** 64 **C** 128 **D** 256

Answer: C

Product after oxidation:



No. of enantiomers = 2^7 = 128

22 Two structural isomers of molecular formula C_6H_{14} are shown.

P $(CH_3)_2CHCH_2CH_2CH_3$

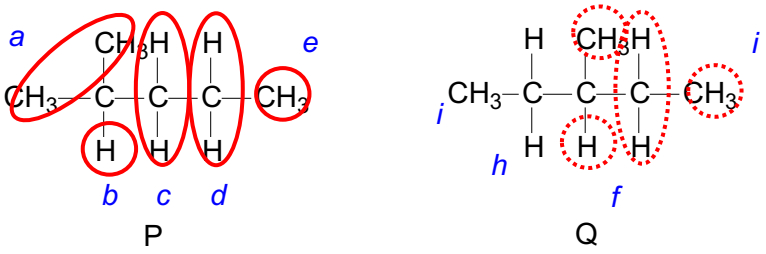
Q $CH_3CH_2CH(CH_3)CH_2CH_3$

P and **Q** react with chlorine to form monochloro compounds $C_6H_{13}Cl$.

How many possible **structural** isomers, each with formula $C_6H_{13}Cl$, could be produced by **P** and **Q**?

	Number of isomers formed by **P**	Number of isomers formed by **Q**
A	5	3
B	5	4
C	6	3
D	6	4

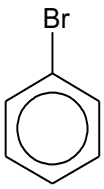
Answer: B

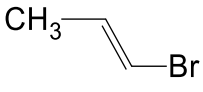


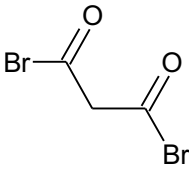
Note: There is a plane of symmetry within a molecule of Q.

23 One gram of each of the following compounds was heated with NaOH(aq), and then dilute HNO_3 and $AgNO_3$(aq) were added.

Which compound will produce the largest mass of AgBr(s)?

A  (M_r: 156.9)

B  (M_r: 120.9)

C  (M_r: 229.8)

D CH_3Br (M_r: 94.9)

Answer: D

Both A and B are resistant to nucleophilic substitution due to the double bond character between C and Br.

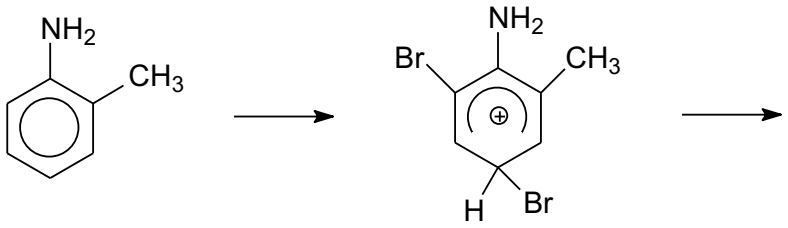
Amt of C in 1g = $\frac{1}{229.8}$ = 0.00435

Hence amt of AgBr formed = 0.0087 mol

Amt of D in 1g = $\frac{1}{94.9}$ = 0.0105

Hence amt of AgBr formed = 0.0105

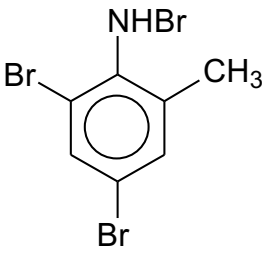
24 When 2-methylphenylamine reacts with an excess of $Br_2(aq)$, one of the intermediates is cation **R**.



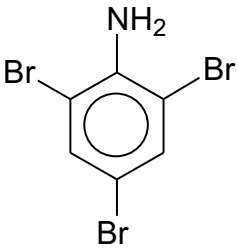
2-methylphenylamine **R**

What is the final product of this reaction?

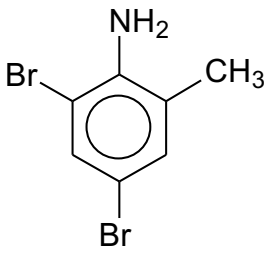
A



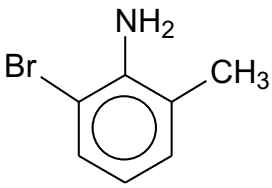
B



C



D



Answer: C

2,4-directing with respect to phenylamine

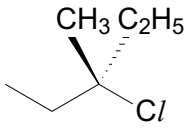
Source: Modified Nov 2012/P1/30

25 Compound **V**, $C_6H_{13}Cl$, reacts with aqueous sodium hydroxide to form **W**, $C_6H_{14}O$.

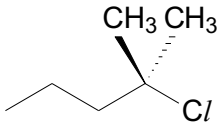
W reacts with alkaline aqueous iodine solution.

What could be the structure of **V**?

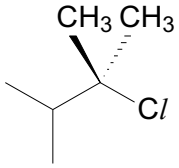
A



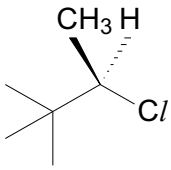
B



C



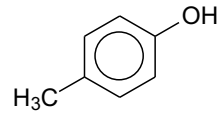
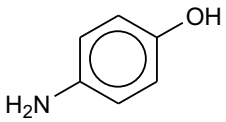
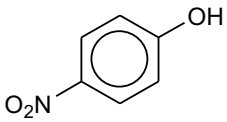
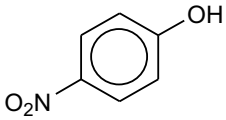
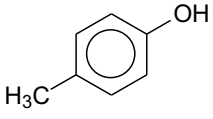
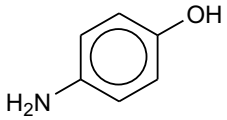
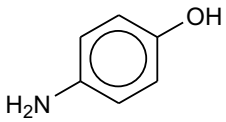
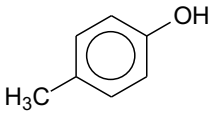
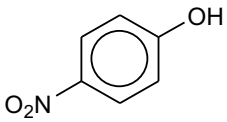
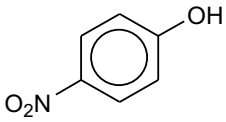
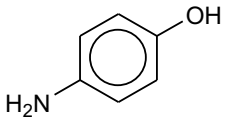
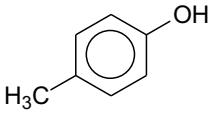
D



Answer: D

W reacts with alkaline aqueous iodine
⇒ presence of $CH_3CH(OH)R$ in **W**
⇒ similarly, presence of $CH_3CH(Cl)R$ in **V**

26 Which row correctly identify the order of acidity of the three compounds?

	least acidic ⟶ most acidic		
A			
B			
C			
D			

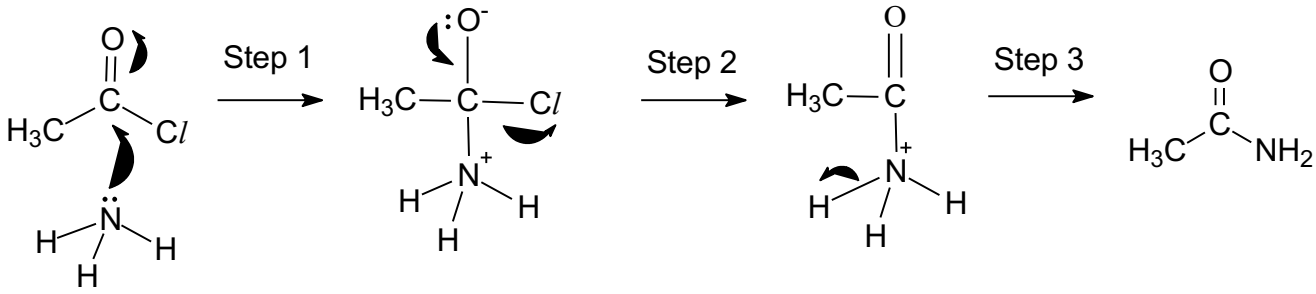
Answer: C

as -NH_2 and -CH_3 are electron donating groups which increase the electron density on the phenoxide anion whereas electron –NO_2 is a withdrawing group which withdraw electron density away from the phenoxide anion.

-NH_2 is a stronger electron donating group than -CH_3 as the lone pair of electrons on nitrogen delocalise into the phenyl ring.

Therefore the phenoxide conjugate base containing -NO_2 is the most stabilised whereas that containing -NH_2 is the most destabilised.

27 A mechanism for the reaction between ammonia and ethanoyl chloride is given below.



Which of the following statements are correct?

1	The ammonia behaves as a nucleophile in the mechanism.
2	The loss of proton in step 3 is shown incorrectly.
3	The oxidation number of the carbonyl C atom in ethanoyl chloride and ethanamide are the same.

A 1,2 and 3

B 1 and 2 only

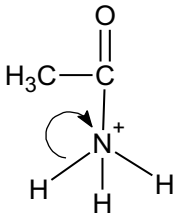
C 1 and 3 only.

D 2 and 3 only.

Answer : A

1: Correct. NH_3 has a lone pair of electrons and uses it to attack the electron deficient carbon.

2: Correct. The arrow in step 3 is shown incorrectly. The correct arrow movement should be

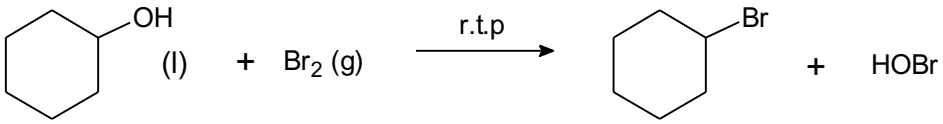


3: Correct.

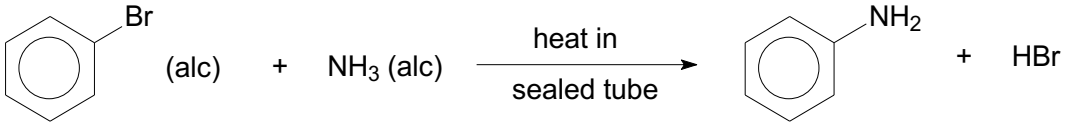
28 Which reaction gives the best yield of products?

[(alc) indicates an alcoholic solution.]

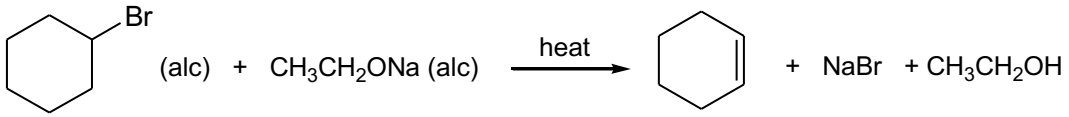
A



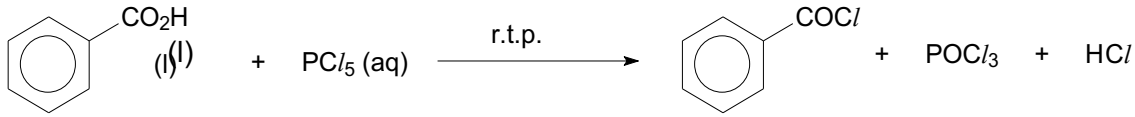
B



C



D



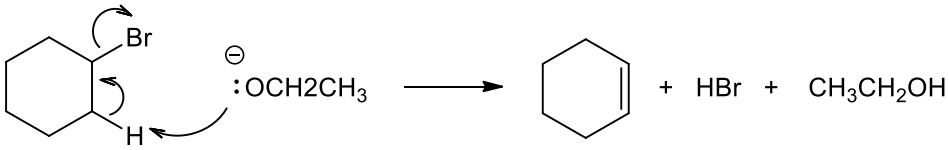
Answer: C

MCQ Tip☺: You may be unfamiliar with reaction from option C but you should have clear understanding that option A, B and C cannot proceed this allowing you to pick option C.

A Substitution of OH with Br requires HBr or PBr_3, as the C-O is strong and difficult to break.

B Br attached to benzene ring is unreactive towards nucleophilic substitution as the p orbital on Br overlaps with the π orbital of benzene resulting in partial double bond character for the carbon-bromine bond which requires more energy to break.

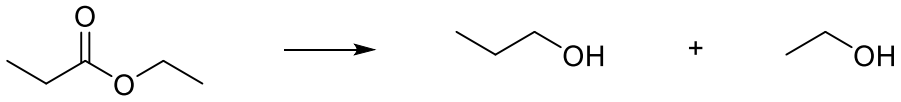
C Elimination of HBr can take place in presence of a strong base in alcoholic medium.
$CH_3CH_2O^-$ is a stronger base than OH^- since the ethyl group is electron donating which intensify the negative charge on oxygen. Thus it is able to abstract the H atom on the carbon next to carbon attached to Br.



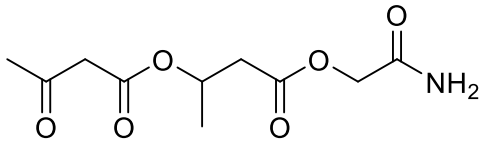
Na^+ is a spectator ion.

D PCl_5 will hydrolyse in aqueous medium and hence anhydrous PCl_5 should be used instead.
$PCl_5 + H_2O \rightarrow 5HCl + H_3PO_4$

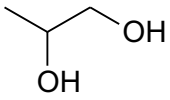
29 Esters can be reduced by LiA/H_4 in dry ether to give two alcohols as shown below.



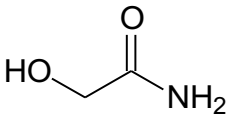
Which of the following is a possible product formed when the following compound is reacted with LiA/H_4 in dry ether?



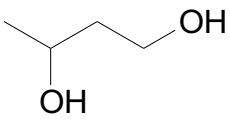
A



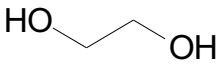
B



C

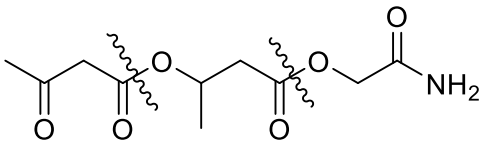


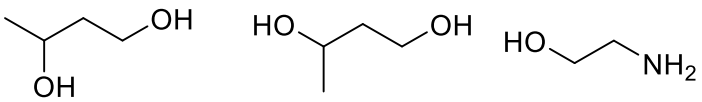
D



Answer: C

Apply the same pattern of reduction across the ester bonds to alcohols, bearing in mind that ketones are also reduced to secondary alcohols and amides are reduced to amines. Hence a total of three fragments are produced after the reaction.





Note that the first two substances are the same ☺

30 Chymotrypsin is an enzyme that hydrolyses protein into smaller peptides and amino acid. It specifically hydrolyses the peptide bond on the carboxylic side of Phe.

The structure of tetrapeptide **X** and M_r of selected amino acids are given below.

tetrapeptide **X**: Val–Lys–Phe–Arg

Amino acid	***M*$_r$**
Val	117
Lys	146
Phe	165
Arg	174

What are the M_r of the two fragments obtained when tetrapeptide **X** is hydrolysed by chymotrypsin.

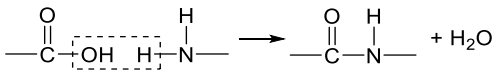
	M_r of fragment 1	M_r of fragment 2
A	428	174
B	392	174
C	339	263
D	321	245

Answer: B

By convention, a polypeptide chain is drawn from the amino end (N-terminus) at the left end to the carboxyl end (C-terminus) at the right end.

N⟶C N⟶C N⟶C N⟶C
Tetrapeptide **X**: Val——Lys——Phe——Arg

Since chymotrypsion digested **X** at the carboxylic acid end of Phe, then the two fragments obtained are Val–Lys–Phe and Arg.

M_r of Val–Lys–Phe	M_r of Arg
117 + 146 + 165 – 2(18) = **392** 1 H_2O (M_r = 18) is lost when 2 amino acids form a peptide. 2 H_2O are lost when 2 amino acids form 2 peptide linkages 	**174**

END