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**IB · DP · Chemistry**

🕐 40 mins    ❓ 40 questions

# Practice Paper 1

**Total Marks**      **/40**

**1** A periodic table is needed to answer this question

A coin contains 5.869% Nickel by mass. If the coin weighs 10.00g, how many Nickel atoms are in the coin?

**A.** $4.30 \times 10^{22}$

**B.** $3.01 \times 10^{23}$

**C.** $6.02 \times 10^{25}$

**D.** $6.02 \times 10^{21}$

**(1 mark)**

**2** *A periodic table is needed for this question*

What mass of a methane, $CH_4$, would occupy a volume of 3 dm$^3$ at 25°C and 100 kPa pressure?

**A.** $\dfrac{100000 \times 3 \times 16.05}{8.314 \times 298}$

**B.** $\dfrac{100 \times 0.003 \times 16.05}{8.314 \times 298}$

**C.** $\dfrac{100000 \times 0.003 \times 16.05}{8.314 \times 25}$

**D.** $\dfrac{100000 \times 0.003 \times 16.05}{8.314 \times 298}$

**(1 mark)**

**3** How many ions are present in 0.02 mol of $(NH_4)_3PO_4$?

**A.** $8.0 \times 10^{-2}$

**B.** $1.2 \times 10^{22}$

**C.** $4.8 \times 10^{22}$

**D.** $2.4 \times 10^{23}$

**(1 mark)**

**4** *A periodic table is needed for this question*

Which row correctly describes the subatomic particles found in $^{26}Mg^{2+}$?

|   | protons | neutrons | electrons |
|---|---------|----------|-----------|
| **A** | 10 | 14 | 12 |
| **B** | 12 | 14 | 10 |
| **C** | 12 | 26 | 10 |
| **D** | 14 | 12 | 12 |

**(1 mark)**

**5** Which of the following calculations gives the correct calculation to find the energy, in kJ, for a photon of blue light given the wavelength $\lambda$ = 550 nm.

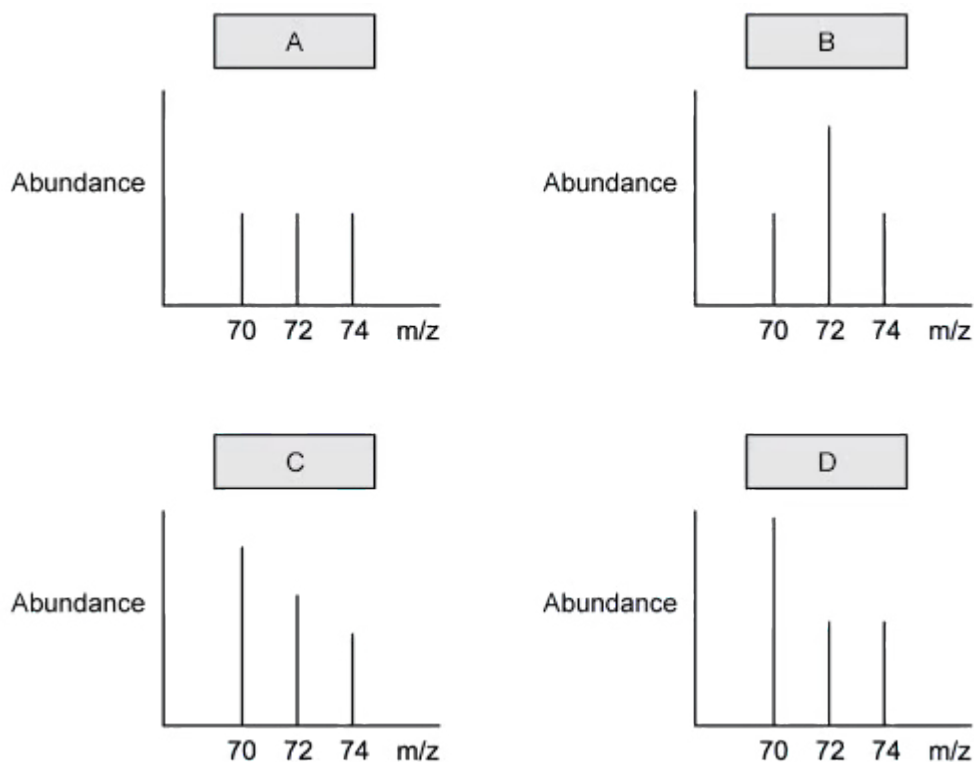*h = 6.626 x $10^{-34}$J s; c = 2.988 x $10^8$ m s$^{-1}$*

**A.** $\dfrac{6.626 \times 10^{-34} \times 2.988 \times 10^8}{550 \times 10^{-9}}$

**B.** $\dfrac{6.626 \times 10^{-34} \times 2.988 \times 10^8}{550 \times 1000}$

**C.** $\dfrac{6.626 \times 10^{-34} \times 2.988 \times 10^{8}}{550 \times 10^{-9} \times 1000}$

**D.** $\dfrac{6.626 \times 10^{-34} \times 2.988 \times 10^{8}}{2.988 \times 10^{8} \times 1000}$

**(1 mark)**

6  Chlorine has two naturally occurring isotopes, $^{35}$Cl and $^{37}$Cl, whose abundance is 75% and 25% respectively. The mass spectrum of chlorine gas would be



**(1 mark)**

**7** The order of the elements in the periodic table is

    **A.** according to relative atomic mass

    **B.** by nuclear charge

    **C.** by reactivity

    **D.** in order of electronegativity

**(1 mark)**

**8** What is the charge on the complex ion in $[Fe(H_2O)_6]Br_2$ ?

    **A.** 0

    **B.** +1

    **C.** +2

    **D.** +3

**(1 mark)**

**9** Which of the following statements about alloys are correct?

    I.  Alloys contain atoms of all the same sizes
    II.  An alloy is a mixture of a metal with another element
    III.  Alloys are harder than the pure metal they originate from

    **A.** I and II only

    **B.** I and III only

    **C.** II and III only

    **D.** I, II and III

**(1 mark)**

**10** In which complexes does iron have an oxidation state of +3?

   I. $[Fe(H_2O)_6]^{3+}$
   II. $[Fe(H_2O)_5(CN)]^{2+}$
   III. $[Fe(CN)_6]^{3-}$

   **A.** I and II only

   **B.** I and III only

   **C.** II and III only

   **D.** I, II and III

**(1 mark)**

**11** Which of the following dipole labels are **not** correct?

A    $\overset{\delta+}{C} \overset{\delta-}{-O}$ in propanol

B    $\overset{\delta+}{C} \overset{\delta-}{=O}$ in propanal

C    $\overset{\delta+}{C} \overset{\delta-}{-H}$ in propane

D    $\overset{\delta+}{C} \overset{\delta-}{-Cl}$ in chloropropane
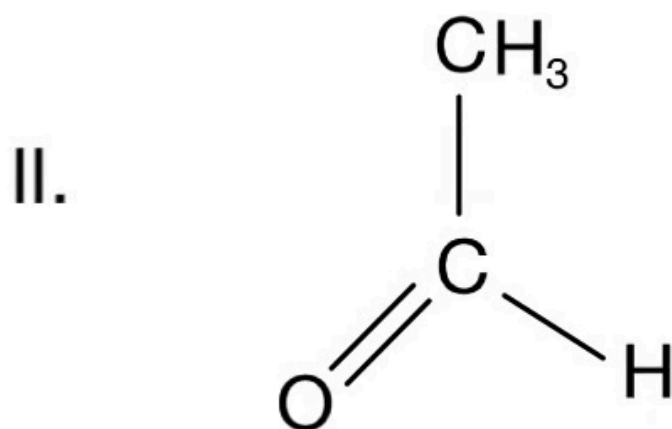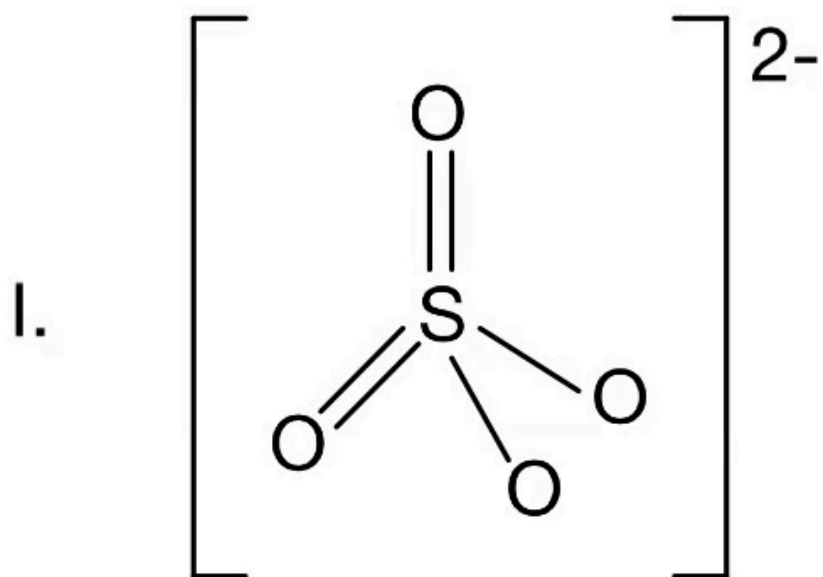
**(1 mark)**

**12** Which row in the table is correct?

| | Shape of diamond structure | Melting point of buckminsterfullerene | Bond angle in graphene |
|---|---|---|---|
| **A** | Square planar | Relatively high | 90º |
| **B** | Tetrahedral | Relatively low | 107º |
| **C** | Trigonal Planar | Relatively high | 109.5º |
| **D** | Tetrahedral | Relatively low | 120º |

**(1 mark)**

**13** Which species contain delocalised electrons?

I.

$$\left[ \begin{array}{c} O = S \underset{O}{\overset{O}{\underset{\displaystyle O}{\big|}}} O \end{array} \right]^{2-}$$

II.

$$CH_3$$
$$C$$
$$O = \quad \quad H$$

III.

$$O = O - O$$
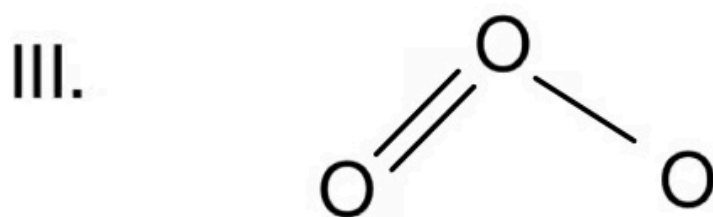
**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**(1 mark)**

**14** Which systems are correctly described?

    I. Matter and energy can be transferred across the boundary of an open system
    II. Only matter can be transferred across the boundary of a closed system
    III. Matter and energy cannot be transferred across the boundary of an isolated system
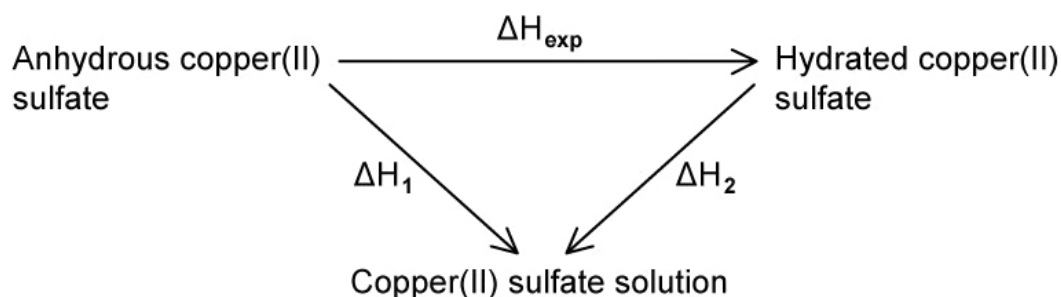
**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**(1 mark)**

**15** The hydration enthalpy of anhydrous copper(II) sulfate, labelled as $\Delta H_{exp}$, cannot be measured directly. It can be found indirectly by determining the solution enthalpies of anhydrous and hydrated copper(II) sulfate.



Which of the following statements correctly explains why the value for $\Delta H_{exp}$ for this reaction cannot be measured directly?

    I. Hydrated copper(II) sulfate is not produced in a controlled manner
    II. Dissolving of the solid is difficult to avoid
    III. Heat energy is trapped inside the solid copper(II) sulfate

**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**(1 mark)**

**16** Which of the following conditions will mean a reaction is never feasible?

|   | ΔH | ΔS | Temperature |
|---|---|---|---|
| **A** | Negative | Positive | High |
| **B** | Positive | Negative | High |
| **C** | Negative | Negative | Low |
| **D** | Positive | Positive | High |

**(1 mark)**

**17** Thermodynamic data for the components for magnesium oxide are

| Name of enthalpy change | Energy change (kJ mol$^{-1}$) |
|---|---|
| Enthalpy of formation of magnesium oxide | -602 |
| Enthalpy of atomisation of magnesium | 150 |
| First and second ionisation energy of magnesium | 2188 |
| Enthalpy of atomisation of oxygen | 248 |
| First and second electron affinity of oxygen | 702 |

Which of the following is used to calculate the lattice enthalpy of magnesium oxide

    **A.** -602 - 150 - 2188 - 248 + 702

    **B.** -602 - 150 - 2188 - 248 - 702

    **C.** -602 - 150 - 2188 - $\frac{248}{2}$ - 702

    **D.** -602 - 150 - 2188 - (2 x 248) - 702

**(1 mark)**

**18** Zinc reacts with copper sulfate according to the following equation:

$$Zn \text{ (s)} + CuSO_4 \text{ (aq)} \rightarrow Cu \text{ (s)} + ZnSO_4 \text{ (aq)}$$
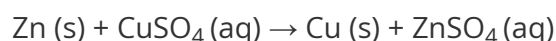
Rates of reaction can be found by measuring how certain properties change during the course of the reaction. Which of these properties could be used?

| | |
|---|---|
| 1 | Change in volume |
| 2 | Change in temperature |
| 3 | Change in colour |

    **A.** 1 and 2 only

    **B.** 1 and 3 only

    **C.** 2 and 3 only

    **D.** 1, 2 and 3

**(1 mark)**

**19** Boltzmann distributions are shown in the two diagrams below.
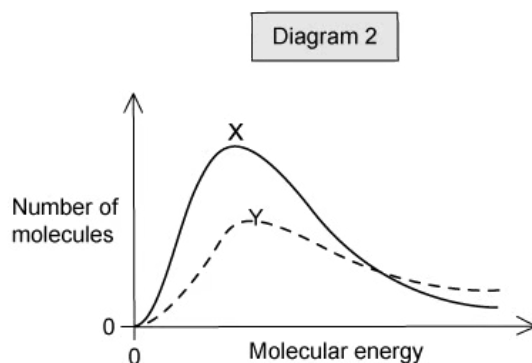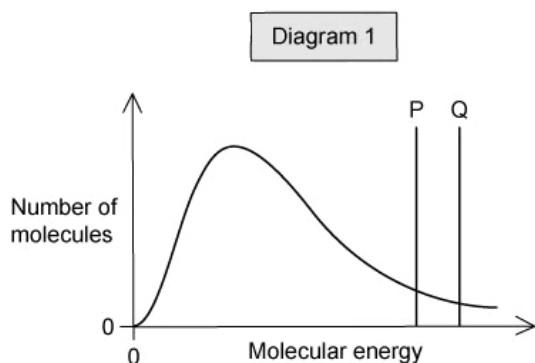
Diagram 1



Diagram 2

In diagram 1, one line, P or Q, corresponds to the activation energy in the presence of a catalyst and the other line corresponds to the activation energy of the same reaction in the absence of a catalyst.

In diagram 2, one curve, X or Y, corresponds to a temperature higher than that of the other curve.

Which combination gives the correct curve and line?

|   | presence of catalyst | higher temperature |
|---|---|---|
| A | P | X |
| B | P | Y |
| C | Q | X |
| D | Q | Y |

**(1 mark)**

**20** Which of the following statements about the rate constant, $k$, are correct?

    I.   High values of $k$ are associated with fast reactions
   II.  The rate constant is affected by temperature
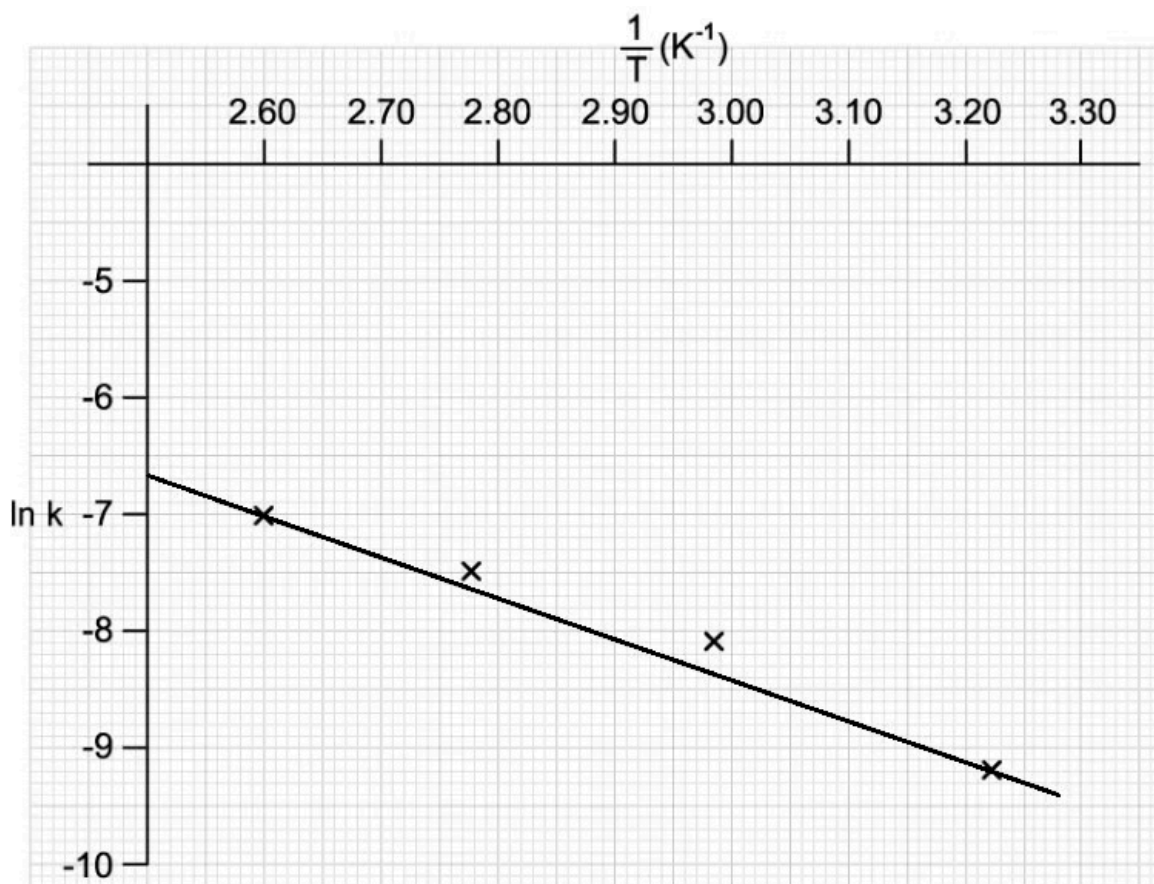  III.  The units of $k$ are independent of the orders of reaction

**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**(1 mark)**



**21** Which of the following statements about the Arrhenius plot are correct?

    I.   The gradient has a value of $E_a \, / \, R$

II. The intercept on the *y*-axis is ln $A$

III. The Arrhenius plot will give a value for activation energy in J mol$^{-1}$

**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**(1 mark)**

**22** When gaseous dinitrogen pentoxide, $N_2O_5$ (g), decomposes at 358 K, the following equilibrium is established:

$$2N_2O_5 \text{ (g) } \rightleftharpoons 4NO_2 \text{ (g) } + O_2 \text{ (g)}$$

2.0 mol of $N_2O_5$ (g) were placed in a 1.0 dm$^3$ container and allowed to reach equilibrium. At equilibrium 1.0 mol of $N_2O_5$ (g) were present. What is the value of $K_c$?

**A.** 0.125

**B.** 1

**C.** 2

**D.** 8

**(1 mark)**

**23** Which change will **not** decrease the entropy of a system?

**A.** Changing state from gas to liquid

**B.** Decreasing the temperature

**C.** A reaction where two moles of gaseous reactants changes to four moles of gaseous products

**D.** Reducing the volume of the container for a gaseous reaction

**(1 mark)**

**24** Using your knowledge of the Brønsted-Lowry theory, which of the following correctly describes ammonia?

**A.** neutral

**B.** acid

**C.** base

**D.** amphoteric

**(1 mark)**

**25** Iron structures can be damaged by dry deposition such as the equation below:

$$Fe\ (s) + SO_2\ (g) + O_2\ (g) \rightarrow FeSO_4\ (s)$$

Which is true?

I. Iron is a reducing agent
II. Sulfur is a reducing agent
III. The enthalpy change is $\Delta H_f$

**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**(1 mark)**

**26** Which of the following statements is **not** correct?

**A.** A Brønsted-Lowry base is a proton acceptor

**B.** Ammonia can act as a Brønsted-Lowry base and Lewis base

**C.** A Lewis acid is an electron pair acceptor

**D.** A hydroxide ion can only act as a Lewis base

**(1 mark)**

**27** The table shows the p$K_a$ and $K_a$ values for four acids

| Acid | p$K_a$ | $K_a$ |
|---|---|---|
| Butanoic Acid | - | $1.51 \times 10^{-5}$ |
| Nitrous acid | 3.1 | - |
| Lactic acid | 3.4 | - |
| Phenol | - | $1 \times 10^{-10}$ |

Which of the following is the correct order of increasing strength of the acids

**A.** Phenol < butanoic acid < lactic acid < nitrous acid

**B.** Nitrous acid < lactic acid < butanoic acid < phenol

**C.** Nitrous acid < butanoic acid < phenol < lactic acid

**D.** Phenol < lactic acid < butanoic acid < nitrous acid

**(1 mark)**

**28** Below are three statements about voltaic cells.

    I.   A redox reaction takes place which produces electrical energy
    II.   At the cathode an oxidation reaction occurs
    III.   Electrons move from the anode to the cathode

The correct statements are

**A.** I and II only

**B.** I and III only

**C.** II and III only

**D.** I, II and III

**29** Use the following electrode potentials to answer the question.

$$Sn^{2+} (aq) + 2e^- \rightleftharpoons Sn (s) \quad E^\theta = -0.14 \text{ V}$$

$$Fe^{3+} (aq) + e^- \rightleftharpoons Fe^{2+} (aq) \quad E^\theta = +0.77 \text{ V}$$
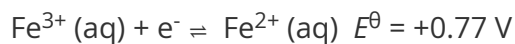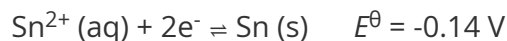
What will be the EMF, in V, when the following voltaic cell is connected?

$$Sn (s) + 2Fe^{3+} (aq) \rightarrow 2Fe^{2+} (aq) + Sn^{2+} (aq)$$
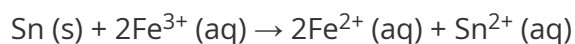
**A.** -0.91

**B.** +0.63

**C.** +1.68

**D.** +0.91

**(1 mark)**

**30** Which of the following can be used for a standard hydrogen electrode (SHE)?

| | Electrode | Electrolyte solution |
|---|---|---|
| **A.** | Graphite | 1 mol dm$^{-3}$ H$_2$SO$_4$ |
| **B.** | Graphite | 1 mol dm$^{-3}$ HCl |
| **C.** | Platinum | 0.5 mol dm$^{-3}$ H$_2$SO$_4$ |
| **D.** | Platinum | 0.5 mol dm$^{-3}$ HCl |

**(1 mark)**

**31** Which of the halogenoalkanes shown below contains a tertiary carbon atom?

**A.** $CH_3CH_2CH_2Cl$

**B.** $CH_3CH_2CH(CH_3)Br$

**C.** $C(CH_3)_3Cl$

**D.** $CH_3CHBrCH_2CH_3$
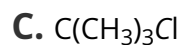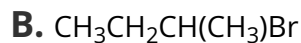
**(1 mark)**

**32** Which compound will react most readily by an $S_N2$ mechanism?

**A.** $(CH_3)_3CBr$

**B.** $CH_3CH_2CH_2CH_2Cl$

**C.** $CH_3CH_2CH_2CH_2Br$

**D.** $(CH_3)_3CCl$
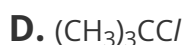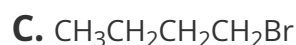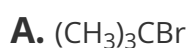
**(1 mark)**

**33** Shown below is a reaction sequence starting with 1-chlorobutane.

$$\quad\quad\quad\quad\quad I \quad\quad\quad\quad\quad II \quad\quad\quad\quad\quad\quad III$$

$$C_4H_9Cl \quad \rightarrow C_4H_9OH \quad \rightarrow \quad C_3H_7COOH \quad \rightarrow \quad C_3H_7COOC_3H_7$$
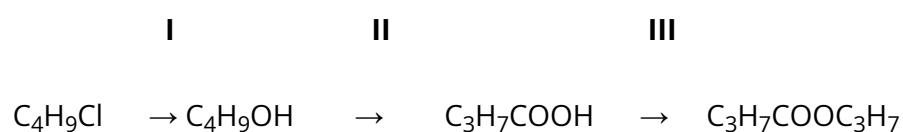
What is the correct classification of the types of reactions shown?

| | I | II | III |
|---|---|---|---|
| A | substitution | oxidation | substitution |
| B | addition | substitution | condensation |
| C | oxidation | substitution | condensation |
| D | substitution | oxidation | condensation |

**(1 mark)**

**34** Which of the following would not be a product of the reaction of pent-1-ene with HCl?

**A.** $CH_2ClCHClCH_2CH_2CH_3$

**B.** $CHClCH_2CH_2CH_2CH_3$

**C.** $CH_3CH_2CHClCH_2CH_3$

**D.** $CH_3(CH_2)_2CHClCH_3$
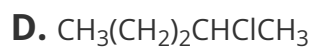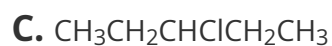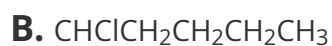
**(1 mark)**

**35** Compound **K**, $C_5H_{12}O$, is oxidised by acidified sodium dichromate(VI) to compound **L**.
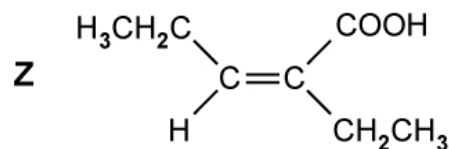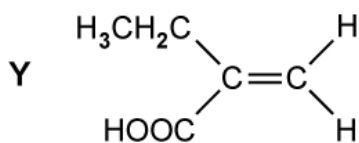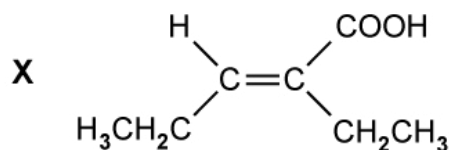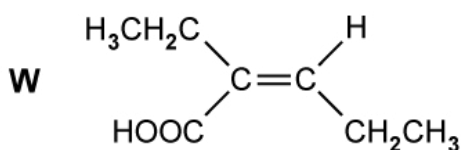
Compound **L** reacts with butan-2-ol in the presence of a little concentrated sulfuric acid to give liquid **M**.

What could be the formula of liquid **M**?

**A.** $(CH_3)_2CHCH_2CO_2C(CH_3)_3$

**B.** $CH_3(CH_2)_3CO_2(CH_2)_3CH_3$

**C.** $CH_3(CH_2)_3CO_2CH(CH_3)CH_2CH_3$
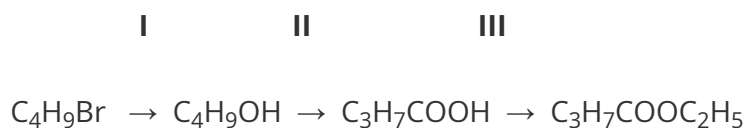
**D.** $CH_3(CH_2)_2CO_2CH_2CH_2(CH_3)_2$

**(1 mark)**

**36** Which two molecules are cis-trans isomers of each other?



**A.** X and Z

**B.** X and Y

**C.** W and Y

**D.** W and Z

**(1 mark)**

**37** The synthesis of ethyl butanoate can be carried out in three steps:

$$\text{I} \qquad \qquad \text{II} \qquad \qquad \text{III}$$

$$C_4H_9Br \; \rightarrow \; C_4H_9OH \; \rightarrow \; C_3H_7COOH \; \rightarrow \; C_3H_7COOC_2H_5$$

What is the correct classification of the steps?

|   | I | II | III |
|---|---|---|---|
| **A** | substitution | oxidation | condensation |
| **B** | addition | substitution | condensation |
| **C** | oxidation | substitution | condensation |
| **D** | substitution | oxidation | substitution |

**(1 mark)**

**38** Below is a $^1$H NMR spectrum for an unknown organic compound. The relative areas under the peaks are labelled
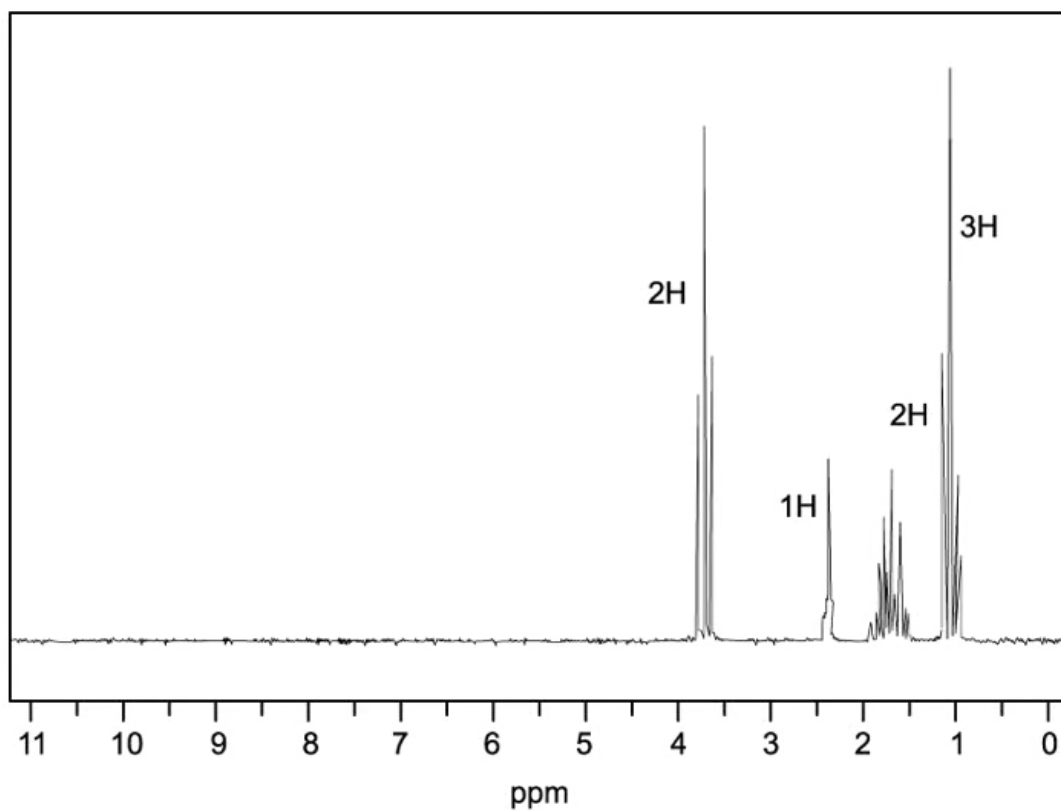
Which of the following compounds could give this spectrum?

**A.** propan-1-ol, $CH_3CH_2CH_2OH$

**B.** propan-2-ol, $CH_3CH(OH)CH_3$

**C.** methyoxyethane, $CH_3OCH_2CH_3$

**D.** pentan-2-one, $CH_3CH_2CH_2COCH_3$

**(1 mark)**

**39**  Propanone is made by a two stage process.

The second stage involves oxidation.

$$\text{Propene} \quad \rightarrow \quad X \quad \rightarrow \quad \text{Propanone}$$

What is the functional group of compound X?

**A.** COOH

**B.** OH

**C.** COO

**D.** C=O

**(1 mark)**

**40**  Which spectroscopic technique can be used to determine bond length and angles?

**A.** Mass spectroscopy

**B.** IR spectroscopy

**C.** X-ray diffraction

**D.** $^1$H NMR spectroscopy

**(1 mark)**