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⏱ 40 mins   ❓ 40 questions

Practice Paper 1

Total Marks   **/40**

1 When lead sulfide reacts with oxygen it produces lead(II)oxide and sulfur dioxide according to the equation below:

$$PbS(s) \ + \ O_2(g) \ \rightarrow \ PbO(s) \ + \ SO_2(g)$$
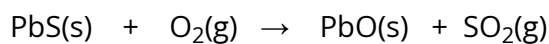
What is the whole number sum of the coefficients in the balanced equation?

   A. 4

   B. 5

   C. 8

   D. 9

(1 mark)

2 *A periodic table is needed for this question*

Excess aqueous cold sodium hydroxide is reacted with 0.10 mol of chlorine gas, Cl_2. One of the products is a compound of sodium, oxygen and chlorine.

What mass of the product is formed?

   A. 3.54 g

   B. 7.44 g

   C. 14.8 g

   D. 26.6 g

(1 mark)

3 Which of the following mixtures is **NOT** classified as homogeneous?

    A. Salt solution

    B. Brass

   **C.** Orange juice that has been filtered

    D. Concrete

(1 mark)

4 The atomic number of an element gives the number of protons in the nucleus which is also equal to the number of electrons. Which statement explains why atoms are neutral?

    A. one proton has a mass 1840 times greater than one electron

    B. the charge on an electron is equal and opposite to the charge on a proton

    C. the difference in charge between electrons and protons is balanced by the neutrons

    D. electrons are spread out in shells around the nucleus while protons are concentrated inside the nucleus

(1 mark)

5 Which transition on the diagram corresponds to the ionisation of hydrogen in the ground state?

Energy

n = ∞
n = 5
n = 4
n = 3
n = 2
n = 1

A   B   C   D
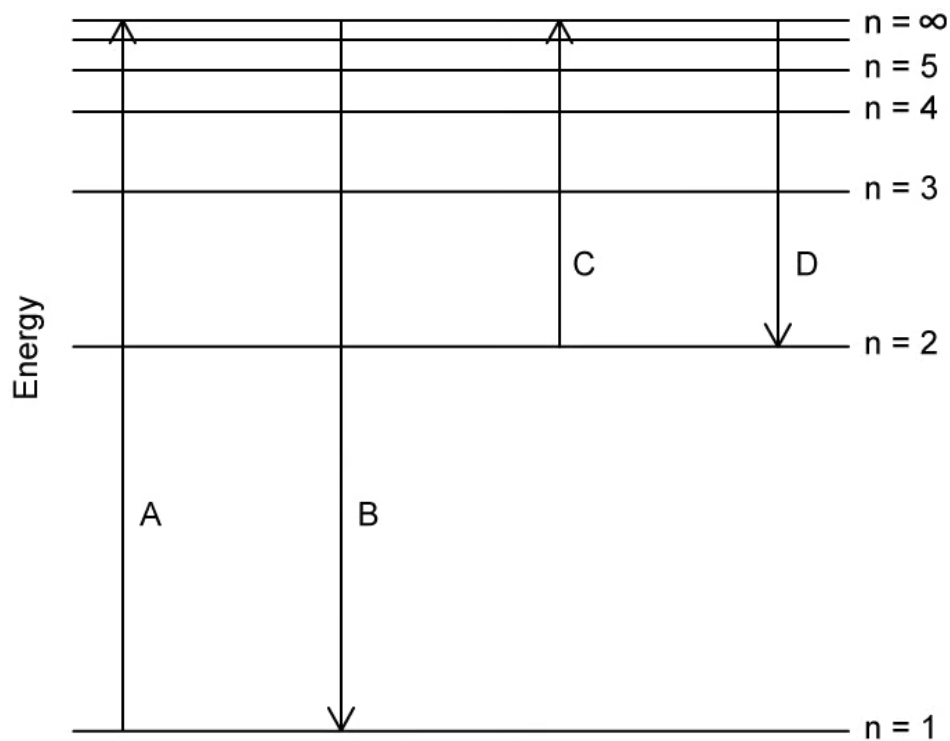
(1 mark)

6 Using the Aufbau Principle and Hund's rule, deduce which element below has the greatest number of unpaired electrons in its ground state.

  A. $Z = 13$

  B. $Z = 14$

  C. $Z = 15$

  D. $Z = 16$

(1 mark)

7 The second ionisation energy of magnesium is 1451 kJ mol^{-1}.

Which equation correctly represents this statement?

A. $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ $\Delta H^\ominus$ = -1451 kJ mol^{-1}

B. $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ $\Delta H^\ominus$ = +1451 kJ mol^{-1}

C. $Mg(g) \rightarrow Mg^{2+}(g) + 2e^-$ $\Delta H^\ominus$ = +1451 kJ mol^{-1}

D. $Mg(g) \rightarrow Mg^+(g) + e^-$ $\Delta H^\ominus$ = -1451 kJ mol^{-1}

(1 mark)

8 Cobalt forms the complex $[Co(NH_3)_5Cl]^{2+}$. Which statements are correct for this complex?

  I. The cobalt ion acts as a Lewis acid.
  II. The cobalt ion has an oxidation state of +2.
  III. There are 90° bond angles between the cobalt ion and the ligands.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

9 Which of the following statements about butane, $CH_3CH_2CH_2CH_3$, and propanone, CH_3COCH_3 are correct?

   I. The boiling point of propanone is higher than butane
   II. The boiling point of butane is higher than propanone
   III. The strongest type of intermolecular force in propanone are permanent dipole permanent dipole forces

   A. I and II only

   B. I and III only

   C. II and III only

   D. I, II and III

(1 mark)

10 Ammonia is a stronger ligand than water. Which statement is correct when concentrated aqueous ammonia solution is added to dilute aqueous copper(II) sulfate solution?

   A. The d-orbitals in the copper ion split.

   B. There is a smaller splitting of the d-orbitals.

   C. Ammonia replaces water as a ligand.

   D. The colour of the solution fades.

(1 mark)

11 Non-metallic elements in the **p** block can have the following two properties:

   property 1   atoms with **no** paired electrons in 3p

   property 2   have an oxide that can form a strong acid in water

   Which properties do phosphorus and sulfur have?

	sulfur	phosphorus
A	2 only	1 and 2
B	1 and 2	2 only
C	1 and 2	1 and 2
D	2 only	1 only

(1 mark)

12 Which of the following molecules obeys the octet rule?

   A. BF_3

   B. HCN

   C. $BeCl_2$

   D. CS_2

(1 mark)

13 Which of the following statements are true for XeO_3?

   I. Has a trigonal pyramidal shape
   II. One possible Lewis structure has two oxygen atoms with a formal charge of -1
   III. Xenon has a formal charge of +2 in one possible Lewis structure

   A. I and II only

   B. I and III only

   C. II and III only

   D. I, II and III

(1 mark)

14 The heat produced by the combustion of magnesium is used to heat some water.

Which values are needed to calculate the energy transferred during the reaction?

   I. The mass of magnesium
  II. The mass of the water
 III. The temperature change of the water
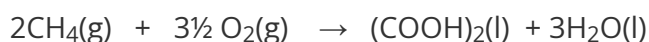
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

15 Shown below are three enthalpy changes:

$CH_4(g)$ + $O_2(g)$ $\rightarrow$ HCHO(l)   + $H_2O(l)$ $\Delta H = x$

HCHO(l)   + $\frac{1}{2}O_2(g)$ $\rightarrow$ HCOOH(l) $\Delta H = y$

2HCOOH(l)   + $\frac{1}{2}O_2(g)$ $\rightarrow (COOH)_2(l) + H_2O(l)$ $\Delta H = z$

Use the information given to deduce the correct expression for the enthalpy change of the following reaction:

$$2CH_4(g) \ + \ 3\tfrac{1}{2} O_2(g) \ \rightarrow \ (COOH)_2(l) \ + 3H_2O(l)$$

A. $x + y + z$

B. $2x + y + z$

C. $2x + 2y + z$

D. $2x + 2y + 2z$

(1 mark)

16 A reaction has a standard entropy change, $\Delta S^{\ominus}$ of +10.00 J K^{-1} mol^{-1}. The same reaction has a standard enthalpy change, $\Delta H^{\ominus}$, of +10.00 kJ mol^{-1}.

Which of the following is used to calculate the value of $\Delta G^{\ominus}$ for the reaction in kJ mol^{-1}?

A. 10 - (298 x 0.001)

B. 10 - (298 x 0.01)

**C.** 10 - (298 x 10)

D. 0.01 - (298 x 10)

(1 mark)

17 Which row of the table correctly represents the equations for the lattice enthalpy of substance W$_2$X and the ionisation energy of atom W?

	Lattice enthalpy	**Ionisation energy**
A.	2W (s) + X$_2$ (g) → W$_2$X	W (g) → W$^+$ (g) + e$^-$
B.	W$_2$X (s) → 2W$^+$ (g) + X^{2-} (g)	W (g) → W^{2+} (g) + 2e$^-$
C.	W$_2$X (s) → 2W$^+$ (g) + X^{2-} (g)	W (g) → W$^+$ (g) + e$^-$
D.	W$_2$X (s) → 2W (g) + X (g)	W (g) → W^{2+} (g) + 2e$^-$

(1 mark)

18 The Boltzmann distribution shows the number of molecules that have particular kinetic energy at a constant temperature.
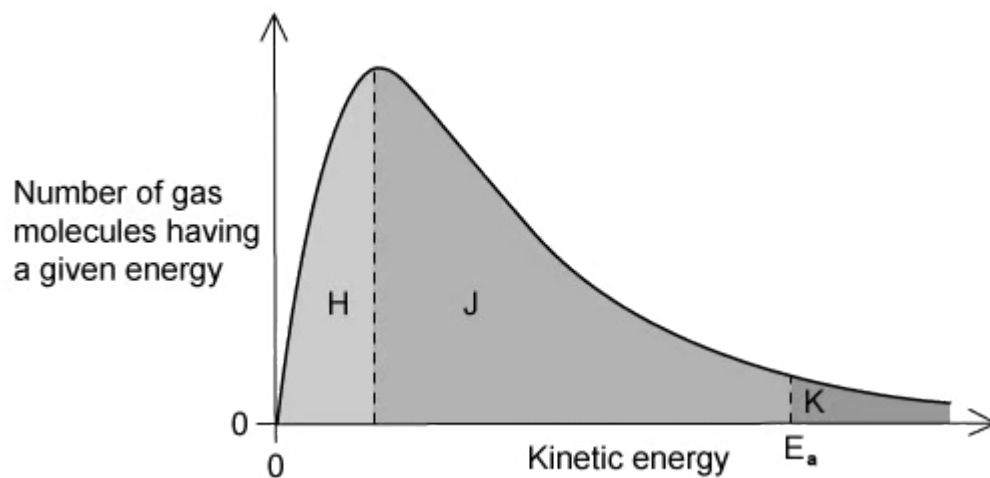
If the temperature is decreased by 10 °C, what happens to the size of the areas labelled *H*, *J* and *K*?

	H	*J*	*K*
A	decreases	decreases	decreases
B	decreases	increases	decreases
C	increases	decreases	decreases
D	increases	decreases	increases

(1 mark)

19 When 1 cm³ of 0.1 mol dm⁻³ HC*l* is added to 10 cm³ of 0.02 mol dm⁻³ $Na_2S_2O_3$ solution, a pale yellow precipitate forms slowly.

When the experiment is repeated with 1 cm³ of 0.1 mol dm⁻³ HC*l* and 10 cm³ of 0.05 mol dm⁻³ $Na_2S_2O_3$ the precipitate forms more quickly.

Why is this?

   A. when 0.05 mol dm⁻³ $Na_2S_2O_3$ is used the reactant particles collide more frequently

   B. when 0.05 mol dm⁻³ $Na_2S_2O_3$ is used the collisions between reactant particles are more violent

   C. when 0.05 mol dm⁻³ $Na_2S_2O_3$ is used the collisions between reactant particles are more violent

   D. when 0.05 mol dm⁻³ $Na_2S_2O_3$ is used the reaction proceeds by a different pathway

(1 mark)

20 The rate information below was obtained for the following reaction at a constant temperature:

$$C_2H_5Br \text{ (aq)} + OH^- \text{ (aq)} \rightarrow C_2H_5OH \text{ (aq)} + Br^- \text{ (aq)}$$

[C_2H_5Br] / mol dm⁻³	[OH^-] / mol dm⁻³	Rate / mol dm⁻³ s⁻¹
3.0 x 10⁻³	2.0 x 10⁻²	4.0 x 10⁻⁴
6.0 x 10⁻³	2.0 x 10⁻²	8.0 x 10⁻⁴
6.0 x 10⁻³	4.0 x 10⁻²	1.6 x 10⁻³

What are the orders of reaction with respect to C_2H_5Br and OH^-?

   A. C_2H_5Br is first order and OH^- is first order

   B. C_2H_5Br is first order and OH^- is second order

C. C_2H_5Br is second order and OH⁻is first order

D. C_2H_5Br is second order and OH⁻ is second order

(1 mark)

21 The following experimental data was collected.

Activation energy, E_a	111 kJ mol⁻¹
Rate constant, k	1.30×10^{-4} mol⁻¹ dm³ s⁻¹
Arrhenius constant, A	4.55×10^{13} mol⁻¹ dm³ s⁻¹

Which expression correctly calculates the temperature of the reaction?

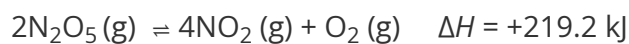**A.** $T = \dfrac{111}{8.31 \times (\ln 4.55 \times 10^{13} - \ln 1.30 \times 10^{-4})}$

B. $T = \dfrac{111 \times 10^3}{8.31 \times (\ln 4.55 \times 10^{13} - \ln 1.30 \times 10^{-4})}$

C. $T = \dfrac{111 \times 10^3}{8.31 \times (\ln 1.30 \times 10^{-4} - \ln 4.55 \times 10^{13})}$

D. $T = \dfrac{111 \times 10^3}{(8.31 \times 10^{-3}) \times (\ln 4.55 \times 10^{13} - \ln 1.30 \times 10^{-4})}$

(1 mark)

22 Which if the following will shift the position of equilibrium to the right in the reaction shown?

$$2N_2O_5 \text{ (g)} \rightleftharpoons 4NO_2 \text{ (g)} + O_2 \text{ (g)} \quad \Delta H = +219.2 \text{ kJ}$$

   I. Decreasing the concentration of NO_2 (g)
  II. Decreasing the temperature
 III. Decreasing the pressure

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

23 Which factors will increase the entropy of this system?

$$CaCO_3 \text{ (s)} \rightleftharpoons CaO \text{ (s)} + CO_2 \text{ (g)}$$

I.   Increasing the temperature without changing the volume of the container.

II.   Decreasing the concentration of the gas without changing the volume of the container.

III.   Increasing the pressure without changing the volume of the container.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

24 What is the sum of the coefficients when the following acid-base equation is balanced?

$$\_HNO_3 \text{ (aq)} + \_Mg(HCO_3)_2 \text{ (s)} \rightarrow \_Mg(NO_3)_2 \text{ (aq)} + \_H_2O \text{ (l)} + \_CO_2 \text{ (g)}$$

A. 5

B. 6

C. 7

D. 8

(1 mark)

25 Acid deposition results in leaching of aluminium ions from the soil. Which are true?

  I. Al^{3+} ions damage plants roots
 II. Al^{3+} ions damage fish gills
III. Al^{3+} ions affect human health

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 about indicators are correct?

    I. The pK_a of the indicator is the midpoint of the pH range
   II. The colour of the indicator depends upon the pH of the solution
  III. At the end point of a titration [HIn] = [In⁻]

    A. I and II only

    B. I and III only

    C. II and III only
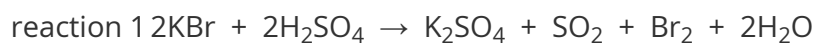
    D. I, II and III

(1 mark)

27 Which of the following statements about conjugate acid and base pairs are correct?

    I.   If an acid has a pK_a value of 4, its conjugate base will have a pK_b value of 10
    II. $K_a + K_b = K_w$
    III.   The conjugate base for ethanoic acid is CH_3COO^-

    A. I and II only

    B. I and III only

    C. II and III only

    D. I, II and III

(1 mark)

28 When solid potassium halides are added to concentrated sulfuric acid, the following reactions take place:

reaction 1 $2KBr + 2H_2SO_4 \rightarrow K_2SO_4 + SO_2 + Br_2 + 2H_2O$

reaction 2 $8KI + 5H_2SO_4 \rightarrow 4K_2SO_4 + H_2S + 4I_2 + 4H_2O$

reaction 3 $2KCl + H_2SO_4 \rightarrow K_2SO_4 + 2HCl$

In each reaction, what is the largest change in the oxidation number of sulfur?

	Reaction 1	Reaction 2	Reaction 3
A	1	4	1
B	2	4	0
C	2	8	0
D	4	8	1

(1 mark)

29 Which of the following is not a condition for the standard hydrogen electrode (SHE)?

A. 1.00 mol dm^{-3} HCl

B. Hydrogen gas with a pressure of 100 Pa

C. Temperature of 298 K

D. Platinum electrodes

(1 mark)

30 Use the following electrode potentials to answer the question.

$$Zn^{2+} (aq) + 2e^- \rightleftharpoons Zn (s) \quad E^\theta = -0.76 \text{ V}$$

$$Cl_2 (aq) + 2e^- \rightleftharpoons 2Cl^- (aq) \quad E^\theta = +1.36 \text{ V}$$

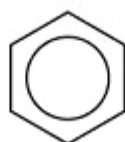$$Mg^{2+} (aq) + 2e^- \rightleftharpoons Mg (s) \quad E^\theta = -2.37 \text{ V}$$

Predict what happens when some powdered zinc is added to aqueous magnesium chloride?

A. There is no reaction observed

B. Bubbles of chlorine gas will be seen

C. Magnesium metal will be produced

D. Zinc chloride will be produced

(1 mark)

31 The structure of benzene is often shown as

This is a representation of a resonance hybrid structure that lies between these two possible structures
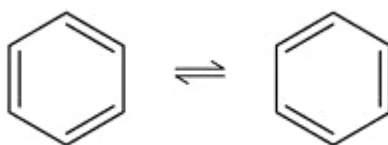
Evidence for this resonance structure is:

I. The carbon-carbon bond lengths lie between the value for a single and a double bond
II. The bond angles are all equal in benzene

III. The enthalpy of hydrogenation of benzene is less exothermic than expected

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

32 What is formed when butanone is heated under reflux with a solution of $NaBH_4$?

A. $CH_3CH_2CHCH_2$

B. $CH_3CH_2CH_2CH_2OH$

C. $CH_3CHOHCH_2CH_3$

D. $CH_3CH_2CH_2CHO$

(1 mark)

33 2.30 g of ethanol were mixed with aqueous acidified potassium dichromate(VI) and the desired organic product was collected by immediate distillation under gentle warming. The yield of the product was 50.0%. (RAMs C= 12, H=1, O=16)

What mass of product was collected?

A. 1.10 g

B. 1.15 g

C. 2.20 g

D. 2.30 g

(1 mark)

34 Which statement is correct about the major reaction between 1-bromobutane, $CH_3CH_2CH_2CH_2Br$, and dilute sodium hydroxide solution, NaOH (aq)?

A. The rate equation is second order.

B. The hydroxide ion acts as a Brønsted–Lowry acid.

C. The reaction has two distinct steps.

D. Water is a product.

(1 mark)

35 What reagents and conditions are needed to convert but-2-ene into butane?

A. Concentrated sulfuric acid, steam, 300°C

B. Hydrogen gas, Ni catalyst, 150°C

C. Acidified potassium dichromate, heating under reflux

D. Hydrogen bromide, room temperature

(1 mark)

36 What is name of this compound applying IUPAC rules?
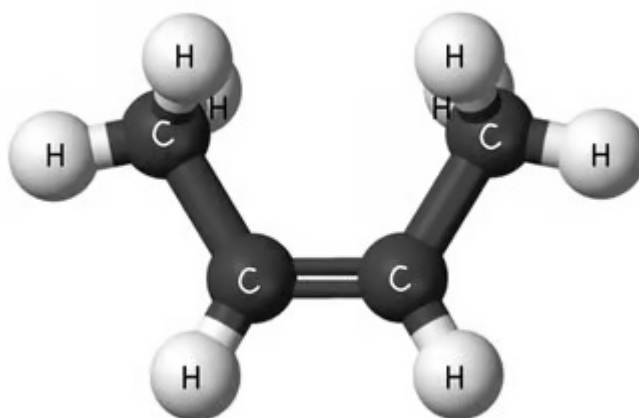
A. Trans-pent-2-ene

B. Trans-but-2-ene

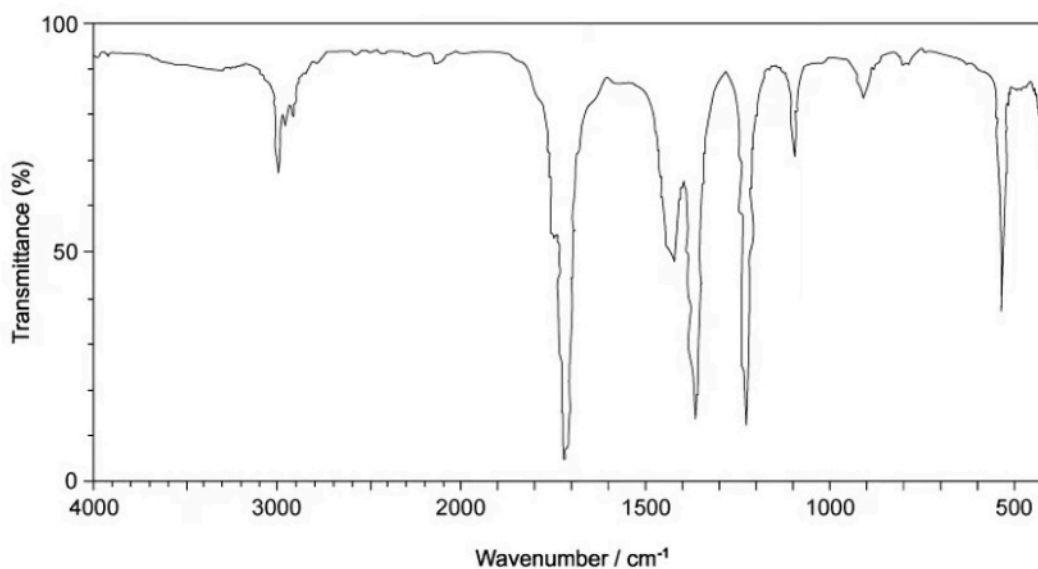**C.** But-1-ene

D. Cis-but-2-ene

(1 mark)

37 Which of the following reactions produces **only** pentan-2-ol?

A. Water and pent-1-ene

B. 1-bromopentane and ethanolic NaOH

C. Water and pent-2-ene

D. 2-bromopentane and ethanolic NaOH

(1 mark)

38 The infrared spectrum of a compound is shown below.

Use the infrared absorptions, in wavenumbers, to identify the compound

bond	wavenumber range/ cm^{-1}
O−H (alcohol)	3750 – 3200
C−H (alkane)	2962 – 2853
C−H (aldehyde)	2900 – 2820 and 2775 – 2700
C=O (aldehyde or ketone)	1740 - 1680

Which compound is shown by the infrared spectrum?

A. propan-1-ol

B. propan-2-ol
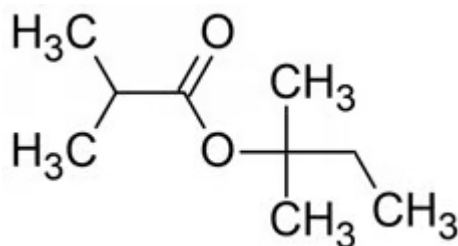
C. propanal

D. propanone

(1 mark)

39 Which of the following produces three peaks in an ^{1}H NMR spectrum?

   I. $CH_3COCH_2CH_3$
 II. $C_6H_5NO_2$
III. CH_3CH_2OH

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

40 The structure of 2-methylbutan-2-yl 2-methylpropanoate is shown below.

How many signals would be found in the ^{1}H NMR spectrum of 2-methylbutan-2-yl 2-methylpropanoate and what would be the ratio of the peak areas?

	Signals	Ratio of peak areas
A	3	2 : 2 : 1
B	4	6 : 6 : 3 : 2
C	5	6 : 6 : 3 : 2 : 1
D	5	3 : 3 : 3 : 2 : 1

(1 mark)