**1** Some chemical tests are described below.

**A** Warm with Fehling's (or Benedict's) solution

**B** Warm with acidified potassium dichromate(VI) solution

**C** Add sodium carbonate solution

**D** Add 2,4-dinitrophenylhydrazine solution

(a) Which test always gives a positive result with carbonyl compounds?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which test would give a positive result with ethane-1,2-diol?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which test would result in effervescence with ethanoic acid?

**(1)**

☒ **A**

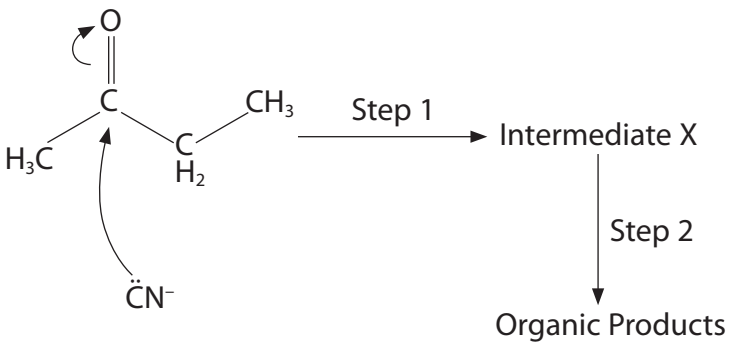
☒ **B**

☒ **C**

☒ **D**

**(Total for Question = 3 marks)**

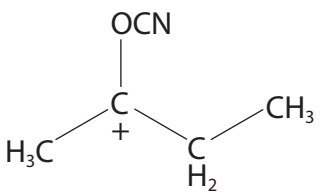
**2** The diagram below shows part of the mechanism for the nucleophilic addition of hydrogen cyanide to butanone.



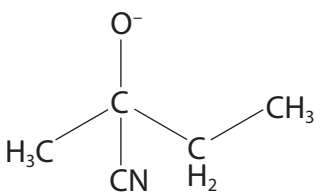

(a) The formula of the intermediate X is

**(1)**

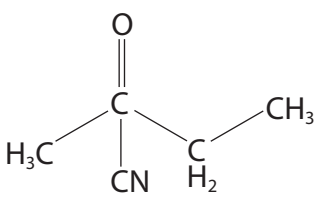
☒ **A**



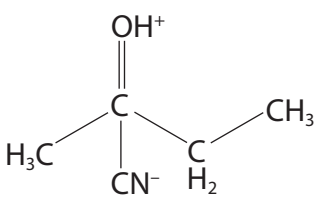

☒ **B**




☒ **C**




☒ **D**



(b) Consider the dissociation of the weak acid, HCN.

$$HCN(aq) \rightleftharpoons H^+(aq) + CN^-(aq)$$

Which of the following reagents would shift the position of the equilibrium towards formation of the nucleophile, $CN^-$?

**(1)**

☒ **A** KOH

☒ **B** KCN

☒ **C** $H_2SO_4$

☒ **D** $CH_3COOH$

(c) Which statement about the mixture of organic products formed is **not** correct?

**(1)**

☒ **A** The mixture contains products with chiral molecules.

☒ **B** The mixture rotates the plane of plane-polarized light.

☒ **C** The mixture contains products with the nitrile functional group.

☒ **D** The mixture contains products each of which has four carbon atoms in a straight chain.

**(Total for Question = 3 marks)**

**3** This question is about four organic compounds, each containing two carbon atoms.

**A** $CH_3CH_2OH$

**B** $CH_3CHO$

**C** $CH_3COOH$

**D** $CH_3COCl$

(a) Which is oxidized by ammoniacal silver nitrate?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which has the highest boiling temperature?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) 0.01 mol of each compound is heated separately with excess acidified sodium dichromate(VI).

Which compound reduces the largest amount of sodium dichromate(VI)?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) 0.01 mol of each compound is added separately to identical volumes of water. Which solution would have the lowest pH?

**(1)**

☒ **A**

☒ **B**

☒ **C**

**D**

**(Total for Question = 4 marks)**

**4** An organic compound reacts with **both** acidified potassium dichromate(VI) **and** lithium tetrahydridoaluminate (lithium aluminium hydride). The organic compound could be

☒ **A** a primary alcohol.

☒ **B** an aldehyde.

☒ **C** a ketone.

☒ **D** a carboxylic acid.

**(Total for Question = 1 mark)**

**5** Ketones react with

☒ **A** both 2,4-dinitrophenylhydrazine solution and Tollens' reagent.

☒ **B** 2,4-dinitrophenylhydrazine solution but not with Tollens' reagent.

☒ **C** Tollens' reagent but not with 2,4-dinitrophenylhydrazine solution.

☒ **D** neither Tollens' reagent nor 2,4-dinitrophenylhydrazine solution.

**(Total for Question = 1 mark)**

**6** A solution of 2,4-dinitrophenylhydrazine (Brady's reagent) is used as a test for organic functional groups.

(a) The positive result of the test is the formation of

**(1)**

☒ **A** a yellow solution.

☒ **B** an orange precipitate.

☒ **C** a red solution.

☒ **D** a green precipitate.

(b) Which of the following gives a positive result with a solution of 2,4-dinitrophenylhydrazine?

**(1)**

☒ **A** Only aldehydes

☒ **B** Only ketones

☒ **C** Only aldehydes and ketones

☒ **D** Any compound containing the C═O group

(c) The initial attack by 2,4-dinitrophenylhydrazine, when it reacts, is by

**(1)**

☒ **A** a free radical.

☒ **B** an electrophile.

☒ **C** a nucleophile.

☒ **D** a negative ion.

(d) The product of a positive test, a 2,4-dinitrophenylhydrazone, contains which of the following bonds?

**(1)**

☒ **A** N═N

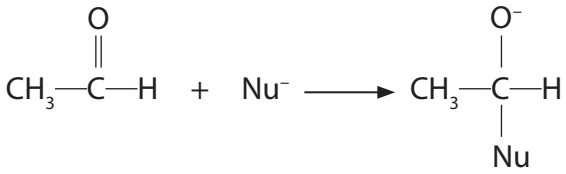
☒ **B** C═N

☒ **C** C═C

☒ **D** C═O

**(Total for Question = 4 marks)**

**7** The first step of a nucleophilic addition reaction to a carbonyl group by a nucleophile, $Nu^-$, is shown below.



The above step is possible because the

☒ **A** nucleophile bonds to the δ+ carbon atom and the carbonyl oxygen accepts an electron pair from the double bond.

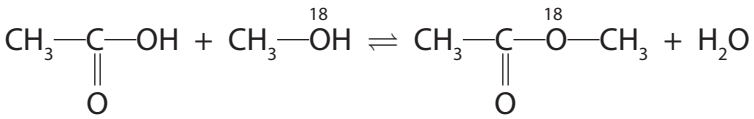
☒ **B** nucleophile bonds to the δ+ carbon atom and the carbonyl oxygen accepts one electron from the double bond.

☒ **C** methyl group donates electrons to the carbonyl carbon atom.

☒ **D** C═O bond is weak.

**(Total for Question = 1 mark)**

**8** In a reaction carried out between ethanoic acid and methanol, the methanol was labelled with the $^{18}O$ isotope. The $^{18}O$ was found to be in the organic product of the reaction



From the above information it can be deduced that the mechanism involves

☒ **A** free radical substitution.

☒ **B** breaking the C—O bond in the ethanoic acid.

☒ **C** nucleophilic attack by ethanoic acid on methanol.

☒ **D** breaking the C—$^{18}O$ bond in methanol.

**(Total for Question = 1 mark)**

**9** This question is about the four organic substances shown below.

**A** $CH_3CH_2CH_2CH_2CHO$

**B** $CH_3CH_2CH_2CH_2COOH$

**C** $CH_3COCH_2CH_2CH_3$

**D** $CH_3CH_2CH_2CH_2COCl$

Which substance will

(a) give a positive result with both Brady's and Tollens' reagents?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) be formed by the oxidation of a secondary alcohol?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) form the most acidic solution when equal amounts are each mixed with 100 $cm^3$ of water?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) form steamy fumes in the reaction with $PCl_5$?

**(1)**

☒ **A**

☒ **B**

☒ **C**

**D**

**(Total for Question 4 marks)**

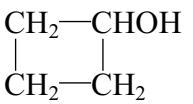
**10** This question is about four compounds with molecular formula $C_4H_8O$.

**A** $CH_3COCH_2CH_3$

**B** $CH_3CH_2CH_2CHO$

**C** $CH_3CH{=}CHCH_2OH$

**D**



(a) The compounds which react when heated with a mixture of potassium dichromate(VI) and sulfuric acid are

**(1)**

☒ **A** compounds **A**, **B** and **C**.

☒ **B** compounds **A**, **B** and **D**.

☒ **C** compounds **A**, **C** and **D**.

☒ **D** compounds **B**, **C** and **D**.

(b) The compound which produces a yellow precipitate when heated with a mixture of iodine and sodium hydroxide is

**(1)**

☒ **A** compound **A**.

☒ **B** compound **B**.

☒ **C** compound **C**.

☒ **D** compound **D**.

(c) There would **not** be a significant peak at mass/charge ratio of 15 in the mass spectrum of

**(1)**

☒ **A** compound **A**.

☒ **B** compound **B**.

☒ **C** compound **C**.

☒ **D** compound **D**.

**(Total for Question 3 marks)**

**11** The following tests can be carried out on organic compounds.

**A** Warm with 2,4-dinitrophenylhydrazine.

**B** Warm with Fehling's or Benedict's solution.

**C** Add solid sodium carbonate.

**D** Add phosphorus(V) chloride, $PCl_5$.

(a) Which test would give a positive result with propanoic acid but not with propan-1-ol?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which test would give a positive result with propanoic acid **and** with propan-1-ol?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which test would give a positive result with propanal but not with propanone?

**(1)**

☒ **A**

☒ **B**

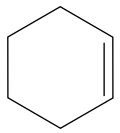
☒ **C**

☒ **D**

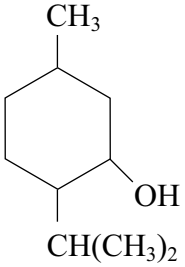
**(Total for Question 3 marks)**

**12** The formulae of some organic compounds labelled **A to D** are shown below.

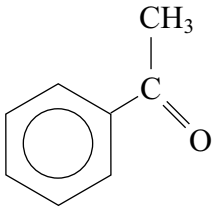
**A**



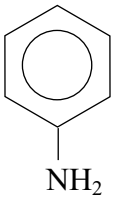
**B**




**C**




**D**




(a) Which compound reacts with sodium to form hydrogen?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which compound forms a green complex ion with $CuSO_4(aq)$?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which compound forms an orange precipitate with 2,4-dinitrophenylhydrazine?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

**(Total for Question 3 marks)**

**13** Which of the following reacts with hydrogen cyanide, HCN, to make a racemic mixture?

☒ **A** Methanal, HCHO

☒ **B** Ethanal, $CH_3CHO$

☒ **C** Propanone, $CH_3COCH_3$

☒ **D** Pentan-3-one, $C_2H_5COC_2H_5$

**(Total for Question = 1 mark)**

**14** Which of the following is a redox reaction?

☒ **A** Ethanal reacting with Tollens' reagent.

☒ **B** Ethanoyl chloride reacting with ammonia.

☒ **C** Ethanoic acid reacting with ethanol.

☒ **D** Ethanoic acid reacting with sodium hydroxide.

**(Total for Question = 1 mark)**

**15** When propanone reacts with iodine in the presence of sodium hydroxide, the crystalline solid product has the formula

☒ **A** $CH_3I$

☒ **B** $CHI_3$

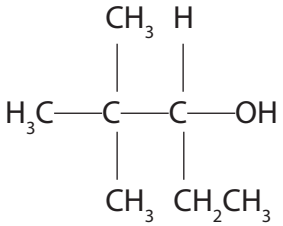
☒ **C** $CH_3COCH_2I$

☒ **D** $CH_3COCI_3$

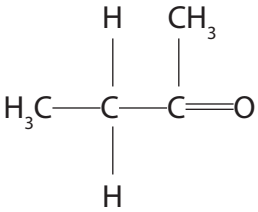
**(Total for Question = 1 mark)**

**16** Questions (a) to (d) concern the following organic compounds.

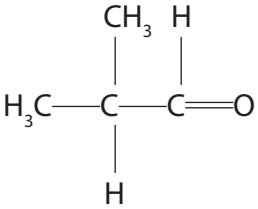
**Compound A**



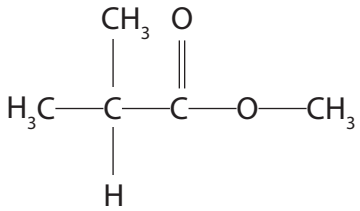

**Compound B**




**Compound C**




**Compound D**



Select from **A** to **D** the compound that

(a) forms iodoform with iodine in the presence of alkali.

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) is chiral.

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) reacts with Tollens' reagent.

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) can be oxidized to form a ketone.

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

**(Total for Question = 4 marks)**

**17** A compound, **Q**, gives an orange precipitate with 2,4-dinitrophenylhydrazine.
Compound **Q** is resistant to oxidation.
On reduction, **Q** gives a product made up of a pair of optical isomers.

Which of the following compounds could be compound **Q**?

☒ **A** $CH_3CH_2CH_2COCH_3$

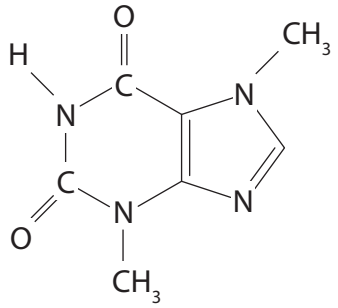
☒ **B** $CH_3CH{=}CHCH(OH)CH_3$

☒ **C** $CH_3CH_2CH_2CH_2CHO$

☒ **D** $CH_3CH_2COCH_2CH_3$

**(Total for Question = 1 mark)**

**18** The compound shown below is found in cocoa beans and in chocolate. Which of the groups listed is **not** present in its structure?




☒ **A** Alkyl

☒ **B** Amide

☒ **C** Amine

☒ **D** Ketone

**(Total for Question = 1 mark)**

**19** The compounds below were heated with aqueous sodium hydroxide solution. Which one of them did **not** give sodium ethanoate, $CH_3COONa$, as one of the products?

☒ **A** $CH_3COOCH_3$

☒ **B** $CH_3COCH_3$

☒ **C** $CH_3COOH$

☒ **D** CH COCl

**(Total for Question = 1 mark)**

**20** Hydrogen cyanide, HCN, reacts with propanal, $CH_3CH_2CHO$, in the presence of potassium cyanide, KCN.

(a) The mechanism for this reaction is

**(1)**

☒ **A** nucleophilic addition.

☒ **B** nucleophilic substitution.

☒ **C** electrophilic addition.

☒ **D** electrophilic substitution.

(b) The first stage of the mechanism of this reaction is

**(1)**

☒ **A** the lone pair of electrons on carbon in CN attacking $C^{\delta+}$ of propanal.

☒ **B** the lone pair of electrons on nitrogen in CN attacking $C^{\delta+}$ of propanal.

☒ **C** the lone pair of electrons on oxygen in propanal attacking $C^{\delta+}$ of HCN.

☒ **D** the lone pair of electrons on oxygen in propanal attacking $H^{\delta+}$ in HCN.

(c) The product of the reaction is

**(1)**

☒ **A** 1-hydroxypropanenitrile.

☒ **B** 2-hydroxypropanenitrile.

☒ **C** 1-hydroxybutanenitrile.

☒ **D** 2-hydroxybutanenitrile.

**(Total for Question 3 marks)**

**21** Which of the following does not have hydrogen bonding in a pure sample, but forms hydrogen bonds with water when it dissolves?

☒ **A** Propane

☒ **B** Propanal

☒ **C** Propanol

☒ **D** Propanoic acid

**(Total for Question 1 mark)**