CHEMISTRY 2021

Unit 4
Key Topic Test 3 – Instrumentation and organic chemistry

Recommended writing time*: 50 minutes
Total number of marks available: 50 marks
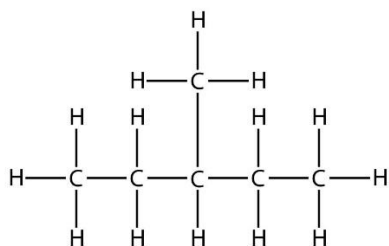
SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: C

Explanation:

The hydrogen atoms on carbons 1 and 2 are equivalent to hydrogen atoms on carbons 4 and 5. So there are 4 hydrogen environments
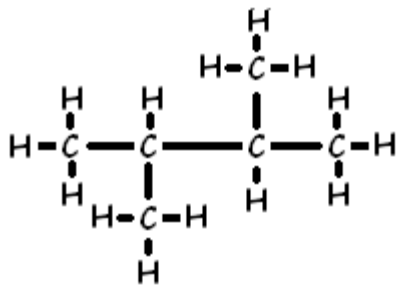

Question 2

Answer: A

Explanation:

Carbon atoms 2 and 3 are in the same environment and the other 4 carbon atoms are all in the same environment so there are 2 carbon environments.
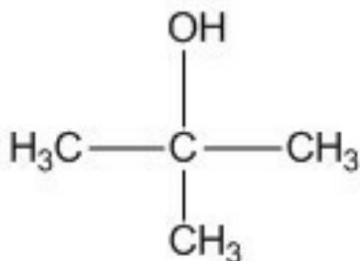

Question 3

Answer: B

Explanation:

There is a hydroxyl group just above $3000cm^{-1}$ and a carbonyl group at about $1700cm^{-1}$ so the molecule is a carboxylic acid.

Question 4

Answer: D

Explanation:

The molecule is 2-methylpropan-2-ol as there only 2 hydrogen environments. One involves each methyl group and one is due to the H on the hydroxyl group.
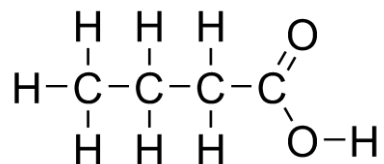

Question 5

Answer: B

Explanation:

The peak just below 300cm^{-1} is due to C-H while the peak at 3300-3400 cm^{-1} is due to N-H.

Question 6

Answer: A

Explanation:

Each of the C atoms is in a different environment and the H atoms coming off each atom are in a different environment.
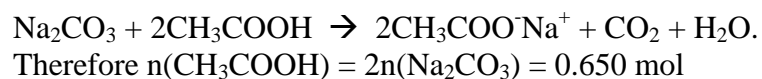
Question 7

Answer: C

Explanation:

Infra-red spectroscopy involves measuring the stretching, bending and twisting of chemical bonds.

Question 8

Answer: C

Explanation:

$Na_2CO_3 + 2CH_3COOH \rightarrow 2CH_3COO^-Na^+ + CO_2 + H_2O$.
Therefore $n(CH_3COOH) = 2n(Na_2CO_3) = 0.650$ mol

Question 9

Answer: C

Explanation:

$n(\text{ethanol}) = {}^3/_2 n(Cr_2O_7{}^{2-}) = {}^3/_2 \times 0.00453 = 0.680$ mol
$m = n \times M = 0.6800 \times 46 = 0.313$ g

Question 10

Answer: D

Explanation:

0.450 g in 20ml
= 5.625 g in 250 mL
So there is 5.625 g in the original 25 mL
Or 22.5g in 100mL = 22.5%

SECTION B: Short-answer questions
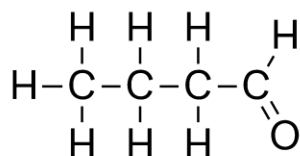
Question 1

a. carbonyl

1 mark

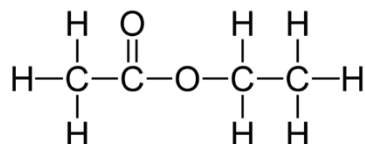**b.** 4

1 mark

c. There is a CH_3 group* which is next to a CH_2 group*

2 marks

d.

2 marks
Total 6 marks

Question 2

Group	Peak area	Splitting
CH_3	3	1
CH_2	2	4
CH_3	3	3

3 peak sets (1 mark) then 0.5 marks for each correct response

4 marks

Question 3
a. Phenolphthalein

1 mark

b. $n = c \times v = 0.100 \times 0.01356 = 0.001356$ mol
$c = n/v = 0.001356/0.02000 = 0.0678$ M

2 marks

c. $n = c \times V = 0.100 \times 0.100 = 0.0100$ mol
$m = n \times M = 0.0100 \times 56.106 = 0.561$g

2 marks

d. i. KOH absorbs water and reacts with CO_2.
ii. You could standardise the KOH by titrating it with a standardised (or made with a primary standard) solution of an acid.

1+2=3 marks

e. If the pipette was washed with water, the benzoic acid would be diluted so the calculated concentration would be lower.

1 mark
Total 9 marks

Question 4
a. **i.** 59 – base peak – peak with 100% intensity
    ii. 60 – parent peak – molecular ion peak
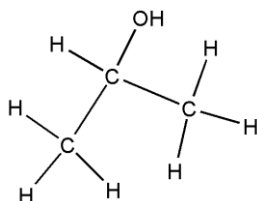
$1 + 1 = 2$ marks

b. CH_2OH^+

1 mark

c. H

1 mark

d.

2 marks
Total 6 marks

Question 5
a. The students need to draw the calibration curve, with the given data in the table, to find out the THC level. It should be between 45 and 46 ng/L

1 mark

b. Either;
    Compare known retention times of THC* using the same solvent and stationary phase.* Or spike the mixture by adding some pure THC*. If the peaks on the resultant graph coincide, the component is THC.*

2 marks

c. **i**. Increased retention time
    ii. Decreased retention time
    iii. Decreased retention time

$3 \times 1 = 3$ marks
gTotal 6 marks

Question 6
- Crush one tablet and dissolve in 50mL of water in a conical flask
- Calculate the mol of vitamin C - $n(Vit\ C) = 0.90 \times 2.20/176 = 0.01225$mol
- Calculate the mol of iodine - $n(I_2) = n(vit\ C) = 0.01225$ mol
- Add a few drops of starch indicator
- Titrate using a burette with 1.00 M iodine solution until a blue/black colour is formed
- Expected titre is: $v = n/c = 0.01125/1.00 = 11.25$ml
- 1 mark for a suitable titre (between 10 mL and 20 mL)

Total 7 marks