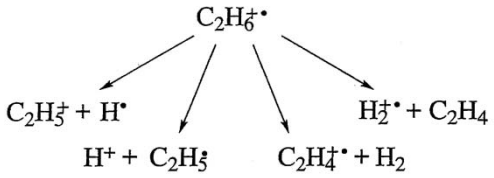
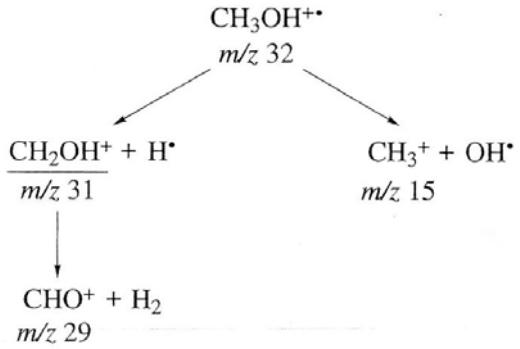
1)

We can, in fact, write four processes, where one produces an atom, another produces a radical and the others both produce molecules. These can be represented as follows:



2)



3) (a) *m/z* 46 (molecular ion)

(b) *m/z* 31 (base peak)

(c) $CH_3CH_2OH^{+\bullet} \longrightarrow CH_2OH^+ + CH_3^\bullet$

The base peak has the same formula as that in the methanol spectrum. It is formed by C—C bond cleavage in the case of ethanol.

(d) In methanol, *m/z* 29 was formulated as CHO^+, which arose from the fragmentation:

$$CH_2OH^+ \longrightarrow CHO^+ + H_2$$

This may also happen with ethanol, but the *m/z* 29 ion may also be formulated as $C_2H_5^+$, which may be formed from the fragmentation:

$$C_2H_5OH^{+\bullet} \longrightarrow C_2H_5^+ + OH^\bullet$$

This second process is analogous to:

$$CH_3OH^{+\bullet} \longrightarrow CH_3^+ + OH^\bullet$$

in methanol.

(e) The steps are the loss of a hydrogen atom from the molecular ion (*m/z* 46) to give *m/z* 45, followed by further loss of a hydrogen molecule from *m/z* 45 to give *m/z* 43.

This can be represented as

$$CH_3CH_2OH^{+\bullet} \longrightarrow CH_3CHOH^+ + H^\bullet$$

$$\downarrow$$

$$CH_3CO^+ + H_2$$

The fragmentations exactly parallel those of methanol.

(f) *m/z* 18 is $H_2O^{+\bullet}$, i.e.

$$C_2H_5OH^{+\bullet} \longrightarrow H_2O^{+\bullet} + C_2H_4$$

(g) The fragmentation pattern is as follows: