6. This question is about the synthesis of Viagra ™

The reaction scheme shown opposite is based on the first synthesis of sildenafil. This is the active ingredient in Viagra, the drug used for the treatment of "male erectile dysfunction".

Note that the by-products are not necessarily indicated in this scheme.

(a) Draw structures for the intermediates **B**, **D**, **E**, **F**, **G**, **I**, and **J**.

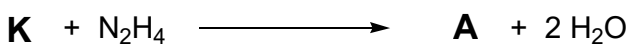
(b) **i)** Suggest suitable reagent(s) for the conversion of **B** to **C**.

ii) Suggest a suitable reagent for the formation of **F** from **E**.

(c) In the formation of **I** from **H**, the first step in the mechanism is a deprotonation by the sodium hydroxide solution. On the answer sheet, indicate clearly which hydrogen is removed by the base.

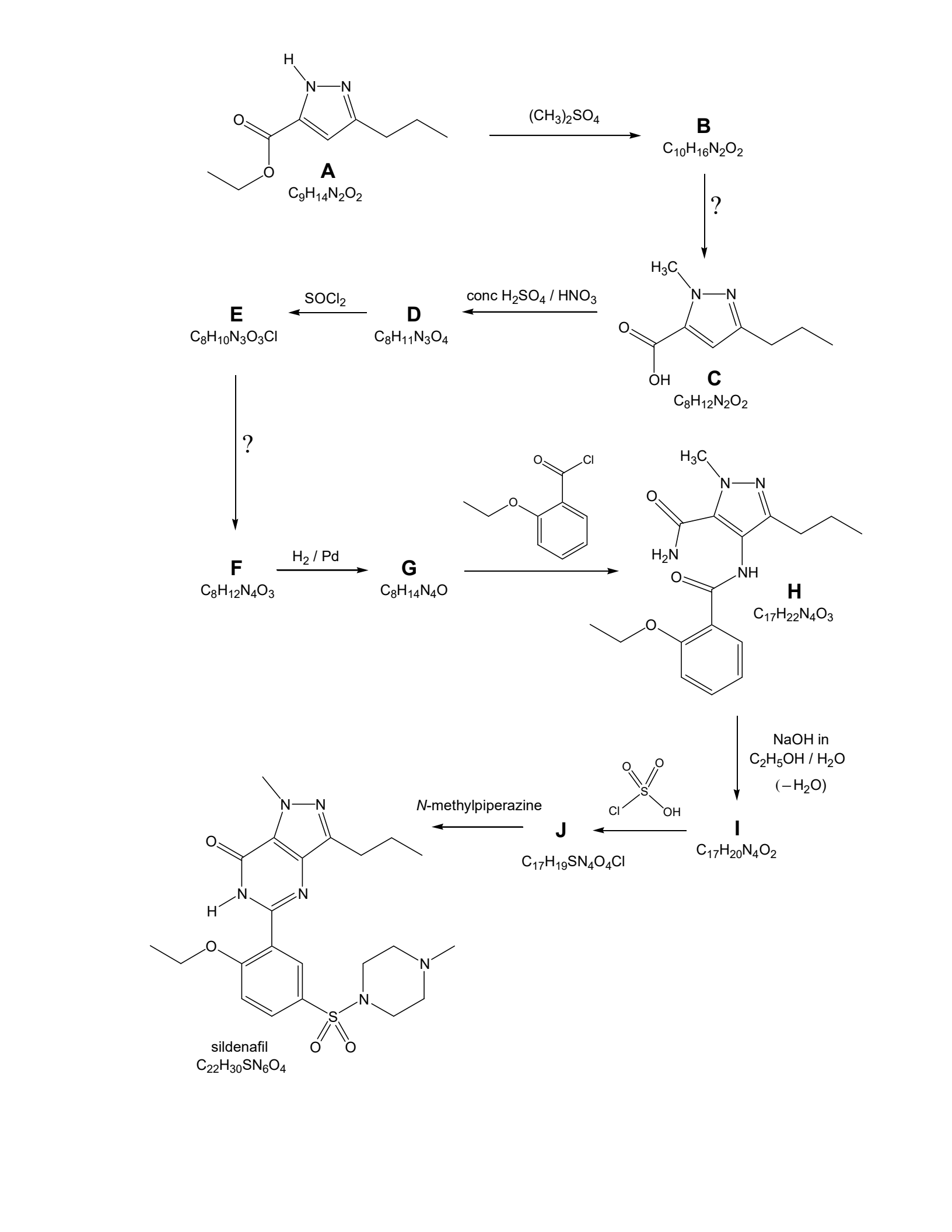
(d) Deduce the structure for *N*-methylpiperazine, the reagent needed to convert **J** to sildenafil.

Compound **A** is actually prepared by the reaction between hydrazine, N_2H_4, and reagent **K** according to the balanced equation below.



(e) **i)** Draw the structure for hydrazine.

ii) Suggest a structure for **K**.


A
$C_9H_{14}N_2O_2$
$(CH_3)_2SO_4$
B
$C_{10}H_{16}N_2O_2$
?
C
$C_8H_{12}N_2O_2$
conc H_2SO_4 / HNO_3
D
$C_8H_{11}N_3O_4$
$SOCl_2$
E
$C_8H_{10}N_3O_3Cl$
?
F
$C_8H_{12}N_4O_3$
H_2 / Pd
G
$C_8H_{14}N_4O$
H
$C_{17}H_{22}N_4O_3$
NaOH in
C_2H_5OH / H_2O
$(-H_2O)$
I
$C_{17}H_{20}N_4O_2$
J
$C_{17}H_{19}SN_4O_4Cl$
N-methylpiperazine
sildenafil
$C_{22}H_{30}SN_6O_4$