**9.15** The following table details the tasks required for Indiana-based Frank Pianki Industries to manufacture a fully portable industrial vacuum cleaner. The times in the table are in minutes. Demand forecasts indicate a need to operate with a cycle time of 10 minutes.

**CRIPTION**

**IMMEDIATE**

**ECESSORS TIME**

IMMEDICATE

ACTIVITY ACTIVITY DESCRIPTION PREDECESSORS TIME

A Attach wheels to tub — 5

B Attach motor to lid — 1.5

C Attach battery pack B 3

D Attach safety cutoff C 4

E Attach filters B 3

F Attach lid to tub A, E 2

G Assemble attachments — 3

H Function test D, F, G 3.5

I Final inspection H 2

J Packing I 2

a) Draw the appropriate precedence diagram for this production line.

b) Assign tasks to workstations and determine how much idle time is present each cycle.

c) Discuss how this balance could be improved to 100%.

d) What is the *theoretical* minimum number of workstations? **PX**