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Part 4. Utility

Question 1:
convert km/h to min/km
- Rocky terrain: 60 / 2 = 30 minutes/km
- Sandy terrain: 60 / 3 = 20 minutes/km
- Smooth terrain: 60 / 5 =12 minutes/km

Calculate time travel for each route
- route 1
  - 20% chance of being sandy, 30% chance of being smooth, and 50% chance of being rocky.
  - expected time per km = 0.2×20+0.3×12+0.5×30 = 22.6 min
  - total time = 5×22.6=113 min
- route 2
  - 40% chance of being sandy, 20% chance of being smooth, and 40% chance of being rocky.
  - Expected time per km: 0.4×20+0.2×12+0.4×30=22.4 min
  - Total time: 7 × 22.4 = 156.8 7×22.4=156.8 min
- route 3
  - 50% chance of being sandy, 40% chance of being smooth, and 10% chance of being rocky.
  - Expected time per km: 0.5×20+0.4×12+0.1×30=17.8 min
  - total time: 6 × 17.8 = 106.8 6×17.8=106.8 min

So we should pick route 3 since it only took 106.8 min

Question2
Now we can add crater and bridge, we can calculate the time again
- route 1
  - Wall is intact and not damaged: 70% chance of saving 20 minutes.
  - Wall is damaged: 30% chance of adding 15 minutes.
  - (0.3×15)−(0.7×20)=4.5−14=−9.5 minutes, means we expect to save 9.5 minutes on Route 1 due to the crater conditions.
  - 113−9.5=103.5 minutes
- route 3
  - bridge is damaged: 60% chance of adding 40 minutes.
  - 0.6×40=24 minutes, means we expect to add 24 minutes to Route 3 due to the bridge condition.
  - 106.8+24=130.8 minutes

After adding create and bridge, time adjusted, Route 1 becomes the best option with an expected travel time of 103.5 minutes.

Question 3
- Calculate Expected Time for Route 2 if Not Rocky
  - Only sandy (40%) and smooth (20%) terrains remain, giving a combined probability of 60%.
  - Sandy = 0.4 / 0.6 = 0.6667
  - Smooth = 0.2 / 0.6 = 0.3333
  - Expected Time per km if not rocky:
    - 0.6667×20+0.3333×12=17.33 min/km
    - Total Expected Time: 7×17.33=121.3 min

If the satellite said that route 2 was not rocky, if will take 7×17.33=**121.3 minutes**

Question 4

- Probability the Satellite Confirms Route 2 is Not Rocky 1 - 0.4 = 0.6, so **60%** probability that the satellite will confirm Route 2 is not rocky.

Question 5

- if Route 2 is rocky, we can go with original probability distribution, which will take 7 × 22.4 = 156.8 7×22.4=156.8 min

Question 6

- Calculate Expected Travel Time for Route 2 if We Wait for Satellite Info
  - If Route 2 is not rocky
    - Expected time per km = (0.6667×20)+(0.3333×12)=13.334+3.9996=17.33 minutes/km
    - Total expected time = 7×17.33=121.3 minutes
  - Combined Expected Time for Route 2
    - 60% chance that Route 2 is not rocky, with expected time of 121.3 minutes.
    - 40% chance that Route 2 is rocky, with expected time of 156.8 minutes.
    - Total time = (0.6×121.3)+(0.4×156.8)=72.78+62.72=135.5 minutes

Given all above calculation, it will take 135.5 min if we wait for satellite, Since the adjusted travel time for Route 1 is 103.5 minutes, which is faster than the expected 135.5 minutes for Route 2, we should not wait for the satellite at all.