Case Study 1

Case Study Paragraph: A company manufactures long transportable fuel tanks shaped as a capsule: a right circular cylinder of length 6.0 meters capped at both ends by hemispheres of radius 1.5 meters. These tanks will be painted on the entire outer curved surface (including both hemispherical ends) with an anti-corrosive coat. The engineering team needs accurate calculations for material ordering, painting cost estimates and capacity planning. Each tank will be filled with diesel and transported to remote depots. For safety checks they also want to know the usable volume in cubic meters and in liters, and how many such tanks are needed to store a specified batch of 200 000 liters. Use $\pi = \frac{22}{7}$ for all calculations. Based on this scenario answer the following questions. (Note: 1 cubic meter = 1000 liters.)

MCQ Questions

1. The total outer curved surface area (cylinder curved surface plus both hemispherical outer surfaces) of one tank is (in square meters):

   (a) 84.86 m^2
   (b) 90.00 m^2
   (c) 80.00 m^2
   (d) 75.43 m^2

   Answer: (a) 84.86 m^2
   Solution: Radius $r = 1.5$ m, cylinder length $h = 6.0$ m.
   Curved surface area of cylinder $= 2\pi rh = 2 \times \frac{22}{7} \times 1.5 \times 6 = \frac{396}{7}$ $\text{m}^2 \approx 56.5714$ m^2.
   Combined outer area of two hemispheres $= 4\pi r^2 = 4 \times \frac{22}{7} \times (1.5)^2 = \frac{198}{7}$ $\text{m}^2 \approx 28.2857$ m^2.
   Total outer curved surface area $= \frac{396 + 198}{7} = \frac{594}{7}$ $\text{m}^2 \approx 84.8571$ $\text{m}^2 \approx 84.86$ m^2. Option (a) matches.

2. The internal volume (capacity) of one tank in cubic meters is:

   (a) 56.57 m^3
   (b) 60.00 m^3
   (c) 50.00 m^3
   (d) 42.43 m^3

   Answer: (a) 56.57 m^3
   Solution: Volume of cylinder $= \pi r^2 h = \frac{22}{7} \times (1.5)^2 \times 6 = \frac{297}{7}$ $\text{m}^3 \approx 42.4286$ m^3.
   Volume of two hemispheres $= \frac{4}{3}\pi r^3 = \frac{4}{3} \times \frac{22}{7} \times (1.5)^3 = \frac{297}{21}$ $\text{m}^3 \approx 14.1429$ m^3.
   Total volume $= \frac{297}{7} + \frac{297}{21} = \frac{1188}{21} = \frac{594}{7}$ $\text{m}^3 \approx 56.5714$ m^3. Option (a) matches.

3. The capacity of one tank in liters (rounded to nearest liter) is:

   (a) 56 571 L
   (b) 42 429 L
   (c) 60 000 L
   (d) 50 000 L

Answer: (a) 56 571 L
Solution: $56.5714\ \text{m}^3 \times 1000 = 56\,571.4$ L. Rounded = 56 571 L. Option (a) matches.

4. If painting is charged at Rs. 35 per square meter for the entire outer curved surface, the painting cost for one tank (rounded to nearest rupee) is:

   (a) Rs. 2970
   (b) Rs. 3000
   (c) Rs. 3200
   (d) Rs. 2850

   Answer: (a) Rs. 2970
   Solution: Total outer area $= \frac{594}{7}\ \text{m}^2$. Cost $= \frac{594}{7} \times 35 = 594 \times 5 = 2970$ Rs. Option (a) matches exactly.

5. How many such tanks are required to store a batch of 200 000 liters of diesel? (Assume whole tanks only)

   (a) 4
   (b) 3
   (c) 5
   (d) 2

   Answer: (a) 4
   Solution: Capacity per tank = 56 571.4 L. Number required $= \frac{200\,000}{56\,571.4} \approx 3.535$. Since only whole tanks can be used, take next whole number = 4. Option (a) matches.