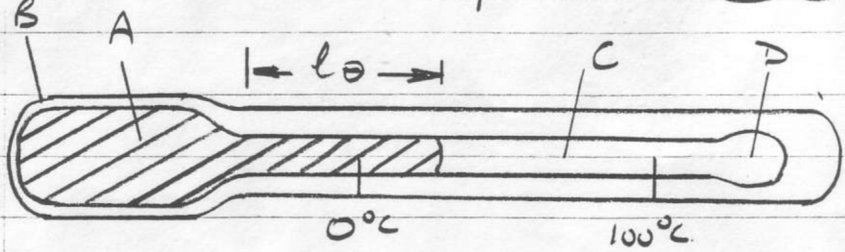
Thermometry – measuring temperature (Questions) A Physics

formula ..

$$\theta = \frac{X_\theta - X_0}{X_{100} - X_0} \times 100\ ^\circ C$$

1.




The standard liquid/glass thermometer has a number of important design features. Can you explain their importance?

(a) large volume of liquid in the bulb (A) (1)

(b) thin glass of bulb (B) (2)

(c) a narrow bore of constant diameter (C) (2)

(d) a space at the top of the bore (D) (1)

(e) Why is it important that the liquid expands more than the glass? (2) $\boxed{8}$

2. Here is some data for a liquid/glass thermometer.

| length of column (cm) | 5.2 | 18.6 | 12.8 | (b) |
|---|---|---|---|---|
| temperature (°C) | 0 | 100 | (a) | 12.5 |

what is temperature (a)? (2)

what is length (b)? (2)

(c) If the stem is 14.2 cm long, what is the maximum temperature the thermometer can read? (2) $\boxed{6}$

3. A platinum resistance thermometer has a resistance of 2.76 Ω at 0°C, and 3.16 Ω at 100°C.

(a) What is the temperature if R = 3.02 Ω? (2)

(b) If the resistance can be read to an accuracy of ± 0.01 Ω, what are the minimum and maximum values of temperature? (2)

(c) What is the possible % error in the temperature? (2)

(d) What is the temperature for R = 2.37 Ω? (2)

(e) If the temperature is 162°C, what will R be? (2) $\boxed{10}$

4 What thermometer systems would you choose, and why, to measure...

(a) a patient's temperature (2)

(b) the temperature of molten aluminium (660°C) (2)

(c) the temperature of liquid nitrogen (~ −196°C) (2) $\boxed{6}$

Q... $\frac{1}{8}$ $\frac{2}{6}$ $\frac{3}{10}$ $\frac{4}{6}$

# Thermometry — 1 Answers A Physics

1. (a) large expansion in volume for a small temp rise (1)
   (b) heat energy conducts through quickly (1), thermometer responds quickly (1)
   (c) liquid level moves a large distance for small temp rise (1) } (2)
   ... constant distance for each °C (1) (uniform scale)
   (d) room for expansion (1)
   (e) so that liquid column length expands more than glass stem (1) and liquid level goes up stem not down (1) } (2) [8]

2. (a) Temp $\theta = \dfrac{X_\theta - X_0}{X_{100} - X_0} \times 100$ (length!) (1) $= \dfrac{(12.8 - 5.2)}{(18.6 - 5.2)} \times 100 = 56.7\ °C$ (1) same s.f. as in Q
   (b) $12.5 = \dfrac{X_\theta - 5.2}{18.6 - 5.2} \times 100$ (1) so... $X_\theta - 5.2 = 1.675$ ... so $X_\theta = \underline{6.9}$ cm (1)
   (c) $\theta_{max} = 14.2 - 5.2 / 18.6 - 5.2$ (1) $= \underline{67\ °C}$ (1) [6]

3. (a) $\theta = \dfrac{X_\theta - X_0}{X_{100} - X_0} \times 100$ (Resistance!) $= 3.02 - 2.76 / 3.16 - 2.76 \times 100$ (1) $= \underline{65.0\ °C}$ (2)
   (b) $\theta$ min for $R_\theta = 3.01$ $= 62.5\ °C$ (1) min } (2)
   $\theta$ max for $R_\theta = 3.03$ $= 67.5\ °C$ (1) max
   ± 2.5 °C (1) error from 65 °C
   (c) % error $2.5 / 65.0 \times 100 = 3.8\ \%$ (1) (2)
   (d) for $R = 2.37\ \Omega$ $\theta = 2.37 - 2.76 / 3.16 - 2.76$ (1) $= -97.5\ °C$ (1) (2)
   (e) for $\theta = 162\ °C$ $= R_\theta - 2.76 / 3.16 - 2.76 \times 100$ (1) so $R_\theta = \underline{3.41}\ \Omega$ (1) (2) [10]

4. (a) liquid in glass (1) — accurate to ± 0.1 °C (quite easily) } 2
   - cheap, small, direct reading in °C
   (b) Pt resistance — can read to temps higher than 660 °C
   - can give remote reading (keep away from heat)
   - can monitor continuously
   (c) Thermistor — can read to low temperatures
   - can be used remotely, continuous reading [6]
   (or Platinum)

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