

Advancing Physics AS

Chapter Test 4

Name:

Set:

1. Steel is stated as having a resistivity of $17.0 \times 10^{-8} \Omega\text{m}$ at room temperature.

(a) Calculate the conductivity of steel at room temperature.

$$G = 1 / R = 1 / 17.0 \times 10^{-8} = 5.88 \times 10^6 \text{ Sm}^{-1} \quad [1]$$

A wire is made from this steel with a length of 2.0m and a cross-sectional area of $5.0 \times 10^{-4} \text{ m}^2$.

(b) Calculate the conductance of this wire at room temperature

$$G = \sigma A / l = 5.88 \times 10^6 \times 5.0 \times 10^{-4} / 2 = 1470 \text{ S} \quad [3]$$

(c) State what happens to the conductance of the wire if it is heated.

The conductance decreases [1]

2. China is said to be both *brittle* and *hard*.

(a) Explain what is meant by the terms in italics.

Brittle – no plastic deformation, it snaps at the elastic limit

Hard – resistant to denting

[2]

(b) State which class of material china is from.

Ceramic

[1]

Rubber is said to be both *elastic* and *tough*.

(c) Explain what is meant by the terms in italics.

Elastic – returns to its original size and shape once load is removed

Tough – resistant to crack propagation (i.e. it will have plastic deformation, this is the opposite of brittle)

[2]

(d) State which class of material rubber is from.

Polymer

[1]

Polythene is said to be both *plastic* and *transparent*.

(e) Explain what is meant by the terms in italics.

Plastic – does not return to its original size and shape once the load is removed

Transparent – lets light pass through it without absorption

[2]

(f) State which class of material polythene is from.

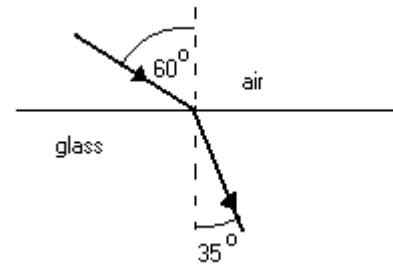
Polymer

[1]

3. The diagram shows a ray of light passing from air to glass.

(a) Calculate the refractive index of glass.

$$n = \sin i / \sin r = \sin 60 / \sin 35 = 1.5$$



[2]

The speed of light in air can be taken to be $3.00 \times 10^8 \text{ ms}^{-1}$.

(b) Calculate the speed of the light ray when it is in the glass.

$$\text{Speed in glass} = \text{speed in air} / n = 3.00 \times 10^8 / 1.5 = 2.00 \times 10^8 \text{ ms}^{-1}$$

[2]

3. Diamond is stated as having a refractive index of 2.42

(a) Calculate the critical angle for diamond.

$$\sin c = 1/n = 1/2.42 = 0.4132 \quad c = 24.4^\circ$$

[2]

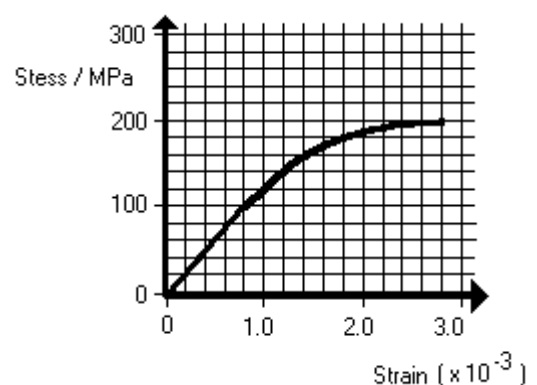
(b) Use this to explain why light gets trapped in diamond for many reflections before finally being emitted into air.

The light will often hit the diamond-air boundary at angles of incidence above 24.4° . Hence it will undergo total internal reflections often.

[2]

4. An experiment is carried out to measure the Young Modulus of a copper wire.

The graph on the right shows the relationship that was found between stress and strain for the copper wire up until breaking point.



- (a) Use the graph to calculate the Young Modulus for the copper wire initially.

$$\text{Initial gradient} = 100 \times 10^6 / 0.8 \times 10^{-3} = 1.3 \times 10^{11} \text{ Pa}$$

[3]

- (b) The wire has a cross-sectional area of 2.0 mm^2 . Calculate the force on it when it is under a strain of 1.4×10^{-3} .

From graph, when strain = 1.4×10^{-3} , stress = 160 M Pa

$$\text{Force} = \text{stress} \times \text{area} = 160 \times 10^6 \times 2 \times 10^{-6} = 320 \text{ N}$$

[3]

- (c) The graph shows the behaviour of the wire up to breaking point. Label the breaking point on the graph with the letter X.

[1]

X is the last point on the graph, i.e. at a strain of 2.8×10^{-3}

- (d) The original length of the wire is 200 mm. Calculate how long it is when it breaks

$$\text{extension} = \text{strain} \times \text{length} = 2.8 \times 10^{-3} \times 200 = 0.56 \text{ mm}$$

$$\text{Hence length} = 200.56 \text{ mm}$$

[2]

5. A constantan wire has the following bits of data known about it:

Resistivity = $4.90 \times 10^{-7} \Omega\text{m}$
Young Modulus = $1.62 \times 10^{11} \text{ Pa}$
Length = 5.00 m
Cross-sectional area = 1.00 mm^2

- (a) Calculate the resistance of the wire.

$$R = \rho l / A = 4.90 \times 10^{-7} \times 5 / 1 \times 10^{-6} = 2.45 \Omega$$

[3]

- (b) A force of 500 N is hung on the wire, this is within the wire's elastic limit. Calculate its new length

$$\text{Stress} = F / A = 500 / 1 \times 10^{-6} = 5 \times 10^8 \text{ Pa}$$

$$\text{Strain} = \text{stress} / E = 5 \times 10^8 / 1.62 \times 10^{11} = 3.086 \times 10^{-3}$$

$$\text{Extension} = \text{strain} \times \text{length} = 3.086 \times 10^{-3} \times 5 = 0.0154 \text{ m}$$

$$\text{Length} = 5.015 \text{ m}$$

[2]

- (c) Calculate the resistance of the wire now

$$R = \rho l / A = 4.90 \times 10^{-7} \times 5.015 / 1 \times 10^{-6} = 2.46 \Omega$$

[1]

- (d) In practice, the resistance of the wire will have changed by more.
State a reason for this.

The cross-sectional area would have decreased slightly

(I accepted the fact that the temperature would have increased although
this does not have an effect on the resistivity of constantan)

[1]