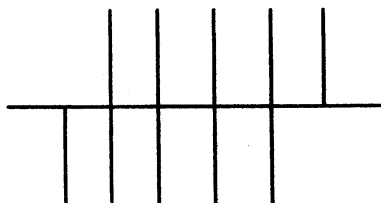




**Mark Scheme 2825/03
January 2002**

1. (a) Equilibrium separation is the normal separation;
when the attractive and repulsive forces (between atoms) balance. (1) [2]
- (b)(i) Positive force shown as repulsion; (1)
Graph showing positive and negative forces; (1)
Correct graph. (1) [3]
- (ii) Label at correct point. [1]
- (iii) Increased separation gives resultant attractive force. [1]
- (iv) Correct statement based on graph drawn; (1)
Straight line/curve through equilibrium position shows extension
proportional/not proportional to force applied (1) [2]
2. (a) Single-crystal: Orderly packing of atoms (to make a large structure with
smooth faces); (1)
Example: e.g. diamond, quartz. (1)
Polycrystalline: Many grains, each a tiny crystal; (1)
Example: e.g. metal (1) [4]
- (b)(i) A slip-plane. (1)
- (ii) A dislocation. (1) [2]
- (c) Suggestion of correct relative movement of planes above and
below PQ. (1)
Completion of diagram showing dislocation moved further to the
right or as below: (1) [2]



3. (a)(i) An electron not bound to an atom/an electron in the conduction band/a delocalised electron. [1]
- (ii) The mean velocity of (free) electrons. [1]
- (b) $I = nAve / v = I/nAe;$ (1)
- Correct substitution in one of above; (1)
- $v = 9.0 \times 10^{-8} \text{ m s}^{-1}$ (1) [3]
- (c) The current falls; (1)
 Raised temperature increases the amplitude of vibration of copper atoms in the wire; (1)
 increasing the number of collisions of free electrons with atoms so reducing the drift velocity. (1) [3]
- (d) Drift velocity is (much) greater in the semiconductor; (1)
 as free electron concentration is (much) smaller. (1) [2]
4. (a)(i) Magnetic axes of domains are randomly orientated/suitable sketch. (1)
- (ii) Magnetic axes of domains aligned/suitable sketch. (1) [2]
- (b)(i) Graph starting from origin and showing B increasing as B_1 increases; (1)
 Graph of correct shape. (1)
- (ii) Graph shows return to positive B. (1) [3]
- (c)(i) A soft magnetic material is used; (1)
 so that energy loss due to hysteresis is small. (1) [2]
- (ii) Core is laminated, with laminations separated by insulator/core is made of insulating ferrite; (1)
 so that heat-producing induced (eddy) currents are small. (1) [2]
5. (a)(i) Semiconductor with separated valence and conduction bands/empty conduction band. (1)
 Metal with overlapping valence and conduction bands/ partly filled conduction band (1) [2]
- (ii) As temperature rises, conductivity rises; (1)
 because, (maximum 2 of 3 marks following)
 More electrons take part in current flow/ (1)
 Valence band electrons gain k.e./thermal energy/ (1)
 More electrons transfer to conduction band. (1) [3]
- (b)(i) Circuit with LDR (not necessarily correct symbol), battery, ammeter, voltmeter; (1)
 correctly connected; (1)
 correct symbol for LDR; (1)
 Daylight: 3 mA (Allow 1 – 5 mA); (1)
 Dark: 3 μA (Allow 1 – 5 μA). (1) [5]
- (ii) Photon energy; (1)
 transfer electrons from valence to conduction band. (1) [2]

(c)(i)	$\theta / ^\circ\text{C}$	$R/\text{k}\Omega$	$1/n (R/\text{k}\Omega)$
	0	140	4.94
	20	66	4.19
	40	31	3.43
	60	14	2.64
	80	6.8	1.92
	100	3.2	1.16

-1 for 2 errors, -2 for 3 or more errors. [2]

(ii) Points correctly plotted (-1 for each error) e.c.f (2)
Straight line drawn (1) [3]

(iii) K recognised as gradient; (1)
Method for finding gradient clear; (1)
 Δy and Δx values correctly read. (1)
 $K/\text{gradient} = -0.038$ tolerance 0.001 (1)
Unit of K: $^\circ\text{C}^{-1}$ (1) [5]

6. (a) Photon energy is insufficient; (1)
to promote electrons from the valance to the conduction band
of the glass; (1)
so they travel through the glass without absorption. (1) [3]

(b)(i) n is greater than 1/greater for glass than air. [1]

(ii) n increases as wavelength of radiation decreases. [1]

(c)(i) Rayleigh scattering is the scattering of light in random directions; [1]

(ii) Due to small variations in the density of the glass. [1]

(iii) The amount of Rayleigh scattering decreases as the wavelength of the
light increases; (1)
Infra-red has shorter wavelength than visible light so is chosen
because Rayleigh scattering is less. (1) [2]

(d) Different wavelengths travel at different speeds in glass; (1)
and cause pulses to be spread out as they travel along a fibre; (1)
A smaller bandwidth minimises the extent of the spreading out. (1) [3]