OCR

RECOGNISING ACHIEVEMENT

A2 MATERIALS

Mark Scheme 2825/3
January 2004

1.	(a)	(i)	polycrystalline;	(1)	
			amorphous.	(1)	[2]
	(b)		e.g. hexagonal (1); face-centred cubic (1).		[2]
	(c)	(i)	correct position of X		[1]
	(d)	(i)	Up to elastic limit: behaviour is elastic and dislocations play no part.	(1)	
			Beyond elastic limit: behaviour is plastic / adjacent layers of atoms slide past each other;	(1)	
			with bonds breaking and reforming;	(1)	
			Dislocations aid this process;	(1)	
			Dislocations move through a crystal;	(1)	
			Dislocations allow plastic behaviour with a smaller force than would be needed with a perfect crystal.	(1)	max [4]
		(ii)	In brass: zinc atoms replace some copper atoms in the crystal lattice;	(1)	
			and prevent the movement of dislocations.	(1)	[2]
2.	(a)		All five points correctly plotted;	(1)	
			Smooth curve through points.	(1)	[2]
	(b)	(i)	r_0 is the equilibrium separation (of the atoms).		[1]
		(ii)	Negative values of F signify a resultant attractive force.		[1]
	(c)		Sensible tangent drawn;	(1)	
			ΔF and Δr values both read;	(1)	
			k calculated: in range - 85 N m^{-1} to -105 N m^{-1}	(1)	[3]
	(d)		E value appropriate to value of k, ignore wrong sign;	(1)	
			Unit of E: Pa or N m^{-2}	(1)	[2]
3.	(a)		Bulb circuit: supply, ammeter correctly placed, voltmeter correctly placed;	(3)	
			LDR connected in series with (milli)ammeter and supply.	(1)	[4]
	(b)		Current through LDR is due to electrons in the conduction band;	(1)	
			Light photons from bulb	(1)	
			provide valence band electrons (in the semiconductor) with energy	(1)	
			to raise them to the conduction band and allow more current.	(1)	[4]
	(c)	(i)	Photon energy required = 2.4 x 1.6 x 10^{-19} = 3.84 x 10^{-19} J	(1)	
			$\lambda = hc/E = 6.63 \times 10^{-34} \times 3.0 \times 10^{8} / 3.84 \times 10^{-19}$	(1)	
			$= 5.18 \times 10^{-7}$ m.	(1)	[3]
		(ii)	Wavelength is maximum because maximum wavelength relates to minimum photon energy / Appropriate reference to $\lambda = hc/E$.		[1]

6. (a) (i) sin 89 = 5.0 / AP (1)
Difference in path length = (AP + BP) – AB
= (2 x 5 / sin 89) - 10 = 10.00152 – 10 (= 0.00152 mm) e.c.f. (1) [2]

(ii) Difference in path length = (0.00152 / 1000) x 100 x 1000 = 0.152 m (1)
Time difference = $0.152 / 2.1 \times 10^{8}$ (1)
= 7.25×10^{-10} s (1) [3]

(b) (i) Shape distorted because transit time of rays varies with path followed. (1)
Height of pulse / amount of light transmitted reduced by: absorption of photons (1)
Rayleigh scattering. (1)
Reduce distortion by: using fibre of smaller diameter (1)
using graded index fibre. (1)

Using infra-red:
Pulse distortion is reduced; (1)
Lower refractive index; (1)
means speed of rays in fibre is greater; (1)
Time difference of paths is smaller; (1)
Pulse height increased / amount of light transmitted increased;0 (1)
Rayleigh scattering is less; (1)
infra-red has longer wavelength than visible / Rayleigh scattering $\alpha\ 1/\lambda^4$. (1) max [8]

7 (a) (i) Idea of zig-zag path (1)
3-5 reflections, i = r, reflection at boundary any 3 (1)
Refractive index of light guide > air (allow denser)
Provided i ≥ C, TIR occurs. (1)

(ii) sin C = 1/n (1)
$C = \sin^{-1}(1/1.58) = 39.3°$. (1)

(b) (i) $E = hc/\lambda = 6.63 \times 10^{-34} \times 3 \times 10^{8}/413 \times 10^{-9}$ Photon energy (1)
$= 4.82 \times 10^{-19}/1.6 \times 10^{-19} = 3.01$ eV eV conversion (1)

(ii) 10^{4} photons = 3.01×10^{4} eV (1)
% conversion = $3.02 \times 10^{4} \times 100\% / 1.5 \times 10^{6} = 2\%$ (1)

(c) (i) $hc/\lambda = 2.2 \times 1.6 \times 10^{-19}$ (1)
$\lambda = 6.63 \times 10^{-34} \times 3 \times 10^{8} / (2.2 \times 1.6 \times 10^{-19})$
= 566 nm 560- 570 nm (1)

(ii) the work function is greater than the photon energy /
no photoelectron emission Or equivalent (1)

(iii) $hf = \phi + \frac{1}{2} m_e v_{max}^2$ Or $hf = \phi$ + KE (1)
$hf - \phi = (3.02 - 2.2) \times 1.6 \times 10^{-19} = 1.31 \times 10^{-19}$J Omit eV (1)
$v_{max} = \sqrt{(2 \times 1.31 \times 10^{-19} / 9.1 \times 10^{-31})} = (5.0 - 5.4) \times 10^{5}\ ms^{-1}$ conversion: 2/3 (1)
KE = 3eV or 2.2eV: 1/3

(d) (i) 3^{12} (1)
= 531000 Allow 3^{13} = 1590000 (1)

(ii) $Q = ne = 531000 \times 1.6 \times 10^{-19} = 8.5 \times 10^{-14}$ C (1)
$I = Q/t = 8.5 \times 10^{-14} / 3 \times 10^{-9}$ (1)
$= 2.8 \times 10^{-5}$ A Q = e: 1/3 (1)

4. (a) Temperature below which the material has zero resistance.

(b)
Easier to attain temperature of 100 K (than 10 K); (1)
Easier to maintain temperature of 100 K (than 10 K); (1)
Liquid nitrogen cheaper than liquid helium; (1)
Greater possibility of everyday applications with 100 K. (1) max

(c)
Super conducting materials used to make the coils of an electromagnet; (1)
Very high current can flow in such coils; (1)
without loss of energy as heat; (1)
Very strong magnetic field produced. (1)
Electromagnet made with superconductor can be much smaller than conventional electromagnet producing the same field strength. (1)
No need for iron core so sample can be inside coil. (1)
No need for equipment to remove excess heat means lower capital cost; (1)
Longer running times possible as heat does not build up. (1) max

5. (a)
1 Domains magnetised in the direction of the magnetising field grow; (1)
the others shrink. (1)
2 Dipoles within the domains; (1)
rotate to line up with the megnetising field. (1)

(b) (i) 1 Power input = 0.025 x 12 = 0.30 W

2 Power output = I^2R (1)
= 0.110^2 x 20 = 0.242 W (1)

3 Efficiency = (output power/ input power) x 100 (1)
= 0.242/0.30 x 100 = 80.7 % (e.c.f) (1)

(ii) New efficiency = (0.105^2 x 20 / 0.30) x 100 (1)
= 73.5 % (e.c.f.) (1)

(c) (i) Heat is produced in the transformer core (1)
EITHER
due to induced / eddy currents flowing in the core (1)
caused by electromagnetic induction; (1)
OR
due to hysteresis losses (1)
as the iron is taken (repeatedly) round its cycle. (1)
OR
domains grow or rotate (1)
requiring energy to realign atoms (1)

(ii) Higher frequency causes greater rate of change of flux (linkage) (1)
causing larger induced / eddy currents; (1)
OR
Higher frequency means more circulations of the hysteresis loop per second (1)
with the same heat produced in each cycle. (1)
OR
rotation / growth happens more frequently (1)
with the same energy required per cycle. (1)