OCR

RECOGNISING ACHIEVEMENT

MATERIALS

Mark Scheme 2825/03
June 2003

The following annotations may be used when marking:

X	=	incorrect response (errors may also be underlined)
^	=	omission mark
bod	=	benefit of the doubt (where professional judgement has been used)
ecf	=	error carried forward (in consequential marking)
[illegible]	=	contradiction (in cases where candidates contradict themselves in the same response)
[illegible]	=	error in the number of significant figures

Abbreviations, annotations and conventions used in the Mark Scheme:

/	=	alternative and acceptable answers for the same marking point
;	=	separates marking points
NOT	=	answers not worthy of credit
( )	=	words which are not essential to gain credit
___ (underlining)	=	key words which <u>must</u> be used
[illegible]	=	allow error carried forward in consequential marking
[illegible]	=	alternative wording
ora	=	or reverse argument

1.	(a)	(i)	amorphous	(1)	
		(ii)	polycrystalline	(1)	[2]
	(b)	(i)	grain boundary: dividing line between the crystals / grains (in a metal).		[1]
			dislocation: part of a plane of atoms is missing.		[1]
		(ii)	point defect / interstitial defect /substitution defect.		[1]
	(c)		Plastic behaviour involves the slippage of one layer of atoms over another.	(1)	
			Dislocations cause weakness in a crystal structure	(1)	
			and allow the slippage to take place more easily.	(1)	[3]
	(d)	(i)	The movement of dislocations (through copper) is limited	(1)	
			as they become pinned / tangled when they meet with a zinc atom.	(1)	[2]
			OR In brass, fracture stress is less than slip stress (1)		
			so material breaks before slip occurs. (1)		
		(ii)	e.g. Wood screws (are made of brass, not copper).		[1]
	(e)	(i)	Mass of ice = 30 x 1 x 920 = 27600 kg	(1)	
			Pressure = F/A = 27600 x 9.8 / 1 = 2.7×10^5 Pa	(1)	[2]
		(ii)	Allows flow to take place.		[1]
2.	(a)		Graph crosses x-axis at x = 0.22 nm;	(1)	
			has minimum at x = 0.26 nm where F = 1.5×10^{-10} N;	(1)	
			is asymptotic to x-axis;	(1)	
			shows steep rise below x = 0.22 nm.	(1)	[4]
	(b)	(i)	Theoretical breaking force = $2.5 \times 10^{13} \times 1.5 \times 10^{-10}$	(1)	
			= 3750 N	(1)	[2]
		(ii)	e.g. Structure contains		
			Dislocations;	(1)	
			Point defects;	(1)	
			Grain boundaries;	(1)	
			All bonds need not break simultaneously;	(1)	
			Surface of wire has cracks.	(1)	
				max [2]	

3.	(a)		Sketch of light ray undergoing total internal reflection / reflections.	(1)	
			Explanation that angles of incidence are greater than critical angle	(1)	[2]
	(b)		Light photons;	(1)	
			provide energy;	(1)	
			to promote / excite electrons in metal atoms to higher energy levels;	(1)	[3]
	(c)	(i)	Scattering due to: small variations of density in the glass / (forced) vibration of (randomly spaced) electrons.		[1]
		(ii)	Amount of scattering is inversely proportional to λ^4 / Reference to $1/\lambda^4$	(1)	
			Scattering of infra-red is $(500/1500)^4 = 1/81$ that of visible.	(1)	
			10/81 % = 0.12 % of infra-red is lost.	(1)	[3]
4.	(a)	(i)	n is number of free electrons / charge carriers per unit volume / m^3.		[1]
		(ii)	$n = I/Ave$	(1)	
			$= 0.0036/(8.2 \times 10^{-6} \times 80 \times 1.6 \times 10^{-19}) = 3.4 \times 10^{19}\ m^{-3}$	(1)	[2]
		(iii)	In a metal the conduction band (of energy levels) is permanently occupied by electrons, so many are available for conduction;	(1)	
			In a semiconductor electrons must be promoted from the valence to the conduction band by thermal energy and few are available at normal temperatures.	(1)	[2]
	(b)	(i)	$I = V/R$	(1)	
			At 0 °C $I = 6/1500 = 0.0040$ A	(1)	
			At 50 °C $I = 6/450 = 0.013$ A	(1)	[3]
		(ii)	More free electrons become available / move into the conduction band	(1)	
			tending to allow more current / lower resistance.	(1)	
			Amplitude of vibration of the atoms of the semi-conductor increases tending to allow less current / higher resistance.	(1)	
			(Changes have opposite effect but) change due to more free electrons is greater so resistance falls.	(1)	[4]
	(c)		The resistance does not change uniformly with temperature.	(1)	
			Scale divisions become farther apart as reading increases,	(1)	[2]
			Allow (1) for reference to logarithmic change of resistance.		

5. (a) (i) 1. Battery connected to right and left ends of slab. (1)
2. Magnetic field directed into or out of paper. (1) [2]
OR 1. Battery connected to front and back of slab . (1)
2. Magnetic field right to left or left to right. (1)

(ii) Points to which voltmeter is connected must be directly opposite. [1]

(b) $B = V_H/vd$ (1)
$= 0.028 / (60 \times 0.008)$ (1)
$= 0.058$ T (1) [3]

(c) Straight line graph of B against V passing through origin. [1]

(d) (i) 1. (Large surface area of semiconductor) slice must be perpendicular to the field. (1)

2. Attach slice to rod. Measure distance x from end to centre of solenoid axis. Push slice distance x into solenoid. (1) [2]

(ii) Arrange solenoid so axis is perpendicular to Earth's field. (1)
Earth's field has no component in east-west direction. (1)
OR
Reverse direction of current and average readings. (1)
Readings taken will be equally above and below correct field value. (1)
OR
Switch current off and measure component of Earth's field along axis. (1)
Find resultant of readings with and without current. (1) [2]

6. (a) (i) Because in an iron atom there is an electron moving in a circular path / a spinning electron. [1]

(ii) The axes of electron spin are aligned / electron orbits are parallel to each other (1)
so that their fields add together. (1) [2]

(b) Soft: Small area loop of correct general shape; (2)
Hard: Large area loop of correct general shape: (2) [4]
[Correct general shape implies no horizontal lines or negative gradients.]

(c) Energy losses due to: hysteresis effects; (1)
eddy currents; (1)
Energy losses produce heat in the core; (1)
Area enclosed by hysteresis loop represents energy loss in 1 cycle (of a.c); (1)
Hysteresis loss reduced if area enclosed by loop is small; (1)
Hence cores made of soft iron / ferrite / metallic glass; (1)
Laminated core reduces eddy current losses; (1)
High resistivity core reduces eddy current losses; (1)
Energy losses increase with frequency of current in coils. (1)
max[7]

7	(a)		Quieter Less pollution/more environmentally friendly	Or other valid point, eg petrol supplies finite, safety(batteries less of fire hazard), can utilise renewable energy	2
	(b)		$P = VI$	0/3 for wrong ans no	1
			750 Wh = 750/12	working	1
			= 62.5 Ah	0.75/12=0.0625 (2/3) 3/3 for correct ans.	1
	(c)	(i)	No. of batteries = 960/16 = 60	-1 for each error	1
			No of kWh = 0.75 x 60 = 45 kWh	1.62 x 10^8 MJ (2/3)	1
			= 45 x 1000 x 3600 =162 MJ		1
		(ii)	Work done = Fd	Allow 1sf if working	1
			D = 162 x 10^6/300	shown	1
			= 540 km		1
	(d)	(i)	Mass of petrol = 162/50 kg	Ecf	1
			= 3.24 kg		1
			Volume = m/ (stated or implied)	Or equivalent	1
			=3.24/700 = 4.6 x10^{-3} m^3		1
		(ii)	Energy lost/not 100% efficient	General comment	1
			As heat etc.	+ detail	1
	(e)		Compare :- • mass, • size, • likely performance of petrol vs batteries, • sensible statement about range Concluding comment	Any 3 from 4	3