EPL-446

MAJOR

09/05/07

Attempt all questions. The marks for questions are given on the right margin. In multiple choice questions, marks will be given only if all the choices are correctly marked. (Total Marks:40)

1. T	Tick the o	correct statement/s	(1)
	(i)	Multilayers like Ni ₈₀ Fe ₂₀ /Cu/Co/Cu with double coercivity show GMR effe	ct
	(ii)	Antiferromagnetically coupled multilayers show GMR effect	
	(iii)	Spin valves show GMR effect in low fields of few tens of Oe.	
_	(iv)	Li is a paramagnet, multilayers of Fe/Li/Fe/Li show GMR effect	
2. F	Propertie	s that are required in magnetic materials used in data storage are-	(1)
	(i)	large permeability	
	(ii)	large remanence	
	(iii)	large coercivity	
	(iv)	large magnetostriction	
	(v)	large magnetoerystalline anisotropy	
		etic layer (NM) of thickness a where the Z of the NM is smaller than the Z nickness $t = N.L$ where $L = a + b$. The energy of electrons in such a sample are independent of N dependent on N independent of b dependent on b	of the F. The
4. Fr	rom the c	defining equation for pole strength p , find its dimensional units in terms of g ,	cm & see. (1)
5. T	he dimer	nsional units of magnetization M and field-strength H are (sa	me/ different),
ifsa	me it is	and if different they are &	(1)

6. Direction of easy-axis in a single domain particle is decided by its anisotropy (1)	_ &
7. When nanomagnetic particles are considered at higher temperatures, k_BT becomesenergy, given by This phenomena is known as (1 ^{1/2})	>>
8. The most striking feature observed in 2D magnetic semiconductors is near band-edge. (1/2)	the
9. When compared, the thinner magnetic sample will have domains (less / m	юге).
The reason for this is (1)	
10. In multilayers of Fe/Cr, Fe layers were ~ 30 A ⁰ and Cr layer thickness were varied between 9 60 A ⁰ . The R / R _H was found to be (largest / smallest) for Cr 9 A ⁰ . In configuration, the strength of AF coupling would be (maximum / minimum) (11). What are the requirements placed on magnetism by Maxwell's equations? What is the phymeaning conveyed by them? (2)	this
12. The magnetic tunnel junction resistivity devices are preferred over GMR devices because of following 3 reasons (3)	of the

.

13. Plot qualitatively the $M \lor s H$ plots for the following:		
(i)	paramagnet	
(ii)	ferromagnet	
(iii)	diamagnet	
(iv)	ferromagnet coated with a thin antiferromagnetic layer	
(v)	nanomagnetic film of Ni with domains oriented along easy-axis and field applied easy axis	d parallel to
(vi)	case above (v) with field applied perpendicular to easy-axis direction	

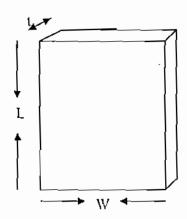
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14.	(5)
(i)The electronic configuration of Fe ²⁺ ion is	·
(ii) Using Hund's rules, the value of S is	
(iii) """""""""""""""""""""""""""""""""""	
	•
(iv)"""" J is	
(v) If spin-only moment is to be considered, the Fe ²⁺ has maximum moment	μ _{Β.}
(vii) If an unit cell volume of Fe ₂ O ₃ is (3.34 x 10 ⁻¹⁰) ³ m ³ , saturation magnetization	tion of Fe ₂ O ₃ will be
A/m.	
,	

15. The direct band-gaps of (Ga,Mn)As and (Al,Ga)As are 1.5 eV and 2.2 eV respectively. Multilayers of above compositions are prepared using MBE technique. The growth is in z direction. (a) <u>Draw</u> the equivalent confining potential diagram with appropriate parameters marked. (b) Assuming that this can be considered as infinite confining potential, <u>write the expression for allowed energy states</u>. (c) <u>Estimate the maximum width for the (Ga,Mn)As quantum well</u> if it is desired that the first two confined states are separated by 40 meV; the effective mass in first and second confined levels are 0.35 m_c and 0.082 m_c respectively. (5)

16. (a) Name the different types of energy densities that are relevant in magnetic materials. How do they contribute towards the domain formation in magnetic materials? (2)

(b) A magnetic sample has length, width and thickness given as L, W, t, as shown in figure. If domain wall energy density is σ_{DW} , show that the total domain wall-energy l unit volume, l where l is the domain size. (4)



(c) If free energy of this magnetic system is given as $(f_W + \text{magnetostatic energy } f_{MS})$ and f_{MS} is given as $(1.7 \ dt \mu_0 M_S^2)/L^2$, show that for minimum energy configuration, the domain size d is given as $d_0 = L(\sigma_{DW} \cdot t \mu_0 M_S^2)^{1/2}$.

(17) What are the factors responsible for noise in GMR / TMR devices?

(2)

Iμ_B = 9.27 x 10⁻²⁴ Axm², h²/m_e = 7.62 eVÅ², m_e = 9.1 x 10⁻³¹ Kg, Atomic number for Fe = 26