Question 1

Calculate the number of vacancies per cubic meter in iron at 850°C. The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65 g/cm^3 and 55.85 g/mol, respectively.

Question 2:

(a) Describe the substitutional and interstitial diffusion mechanisms in solid metals

(b) Cite two reasons why interstitial diffusion is normally more rapid than vacancy diffusion

(c) Describe the factors that affect diffusion and discuss their effects

Question 3

Determine the carburizing time necessary to achieve a carbon concentration of 0.45 wt% at a position 2 mm into an iron–carbon alloy that initially contains 0.20 wt% C. The surface concentration is to be maintained at 1.30 wt% C, and the treatment is to be conducted at 1000°C. Use the diffusion data for γFe in Table below.

Diffusing Species	*Host Metal*	D_0 (m^2/s)	*Activation Energy* Q_d		*Calculated Values*	
			kJ/mol	*eV/atom*	*T(°C)*	*D* (m^2/s)
Fe	α-Fe (BCC)	2.8×10^{-4}	251	2.60	500 900	3.0×10^{-21} 1.8×10^{-15}
Fe	γ-Fe (FCC)	5.0×10^{-5}	284	2.94	900 1100	1.1×10^{-17} 7.8×10^{-16}
C	α-Fe	6.2×10^{-7}	80	0.83	500 900	2.4×10^{-12} 1.7×10^{-10}
C	γ-Fe	2.3×10^{-5}	148	1.53	900 1100	5.9×10^{-12} 5.3×10^{-11}
Cu	Cu	7.8×10^{-5}	211	2.19	500	4.2×10^{-19}
Zn	Cu	2.4×10^{-5}	189	1.96	500	4.0×10^{-18}
Al	Al	2.3×10^{-4}	144	1.49	500	4.2×10^{-14}
Cu	Al	6.5×10^{-5}	136	1.41	500	4.1×10^{-14}
Mg	Al	1.2×10^{-4}	131	1.35	500	1.9×10^{-13}
Cu	Ni	2.7×10^{-5}	256	2.65	500	1.3×10^{-22}

Question 4

The diffusion coefficients for iron in nickel are given at two temperatures:

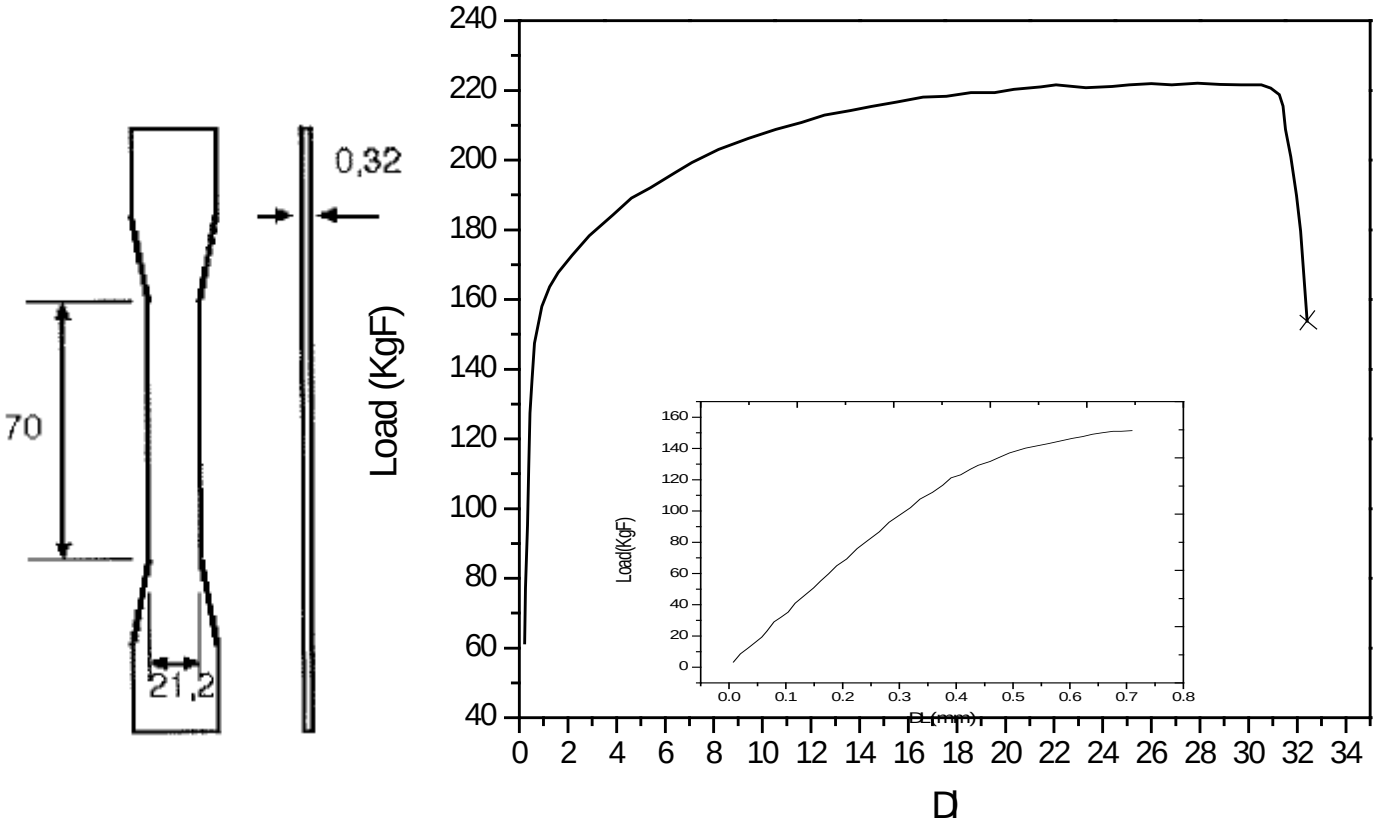
T (K)	D (m^2/s)
1273	9.4×10^{-16}
1473	2.4×10^{-14}

(a) Determine the values of D_0 and the activation energy Q_d.

(b) What is the magnitude of D at 1100ºC (1373 K)?

Question 5

Determine the 0.2% offset Yield Strength, the Percent Elongation and the Tensile Strength for the specimen with the dimensions given below in mm.



Question 6

Describe in detail the main features of the stress-strain curves shown in the following figures at the key points labelled a,b,c etc.
Using the information given suggest the material that each curve might belong to?