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Material Science

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CLASS TEST 2019-2020

MECHANICAL ENGINEERING

Date of Test : 15/06/2019

ANSWER KEY ➤ Material Science

1.	(d)	7.	(a)	13.	(b)	19.	(b)	25.	(a)
2.	(c)	8.	(b)	14.	(c)	20.	(c)	26.	(c)
3.	(b)	9.	(b)	15.	(c)	21.	(d)	27.	(a)
4.	(b)	10.	(c)	16.	(d)	22.	(d)	28.	(c)
5.	(b)	11.	(a)	17.	(b)	23.	(b)	29.	(b)
6.	(b)	12.	(b)	18.	(a)	24.	(c)	30.	(b)

DETAILED EXPLANATIONS

1. (d)

Plain carbon steels can have poor weldability because as carbon content increases, weldability decreases.

2. (c)

When cast iron is slowly cooled, the cementite decomposes into iron and carbon in form of graphite which is called graphitisation. Cast irons, where a large percentage of cementite is decomposed by graphitisation are called grey cast iron. Cast iron in which graphitisation has not taken place i.e. all carbon is in the combined form, is called white cast iron.

3. (b)

Alloying elements in steels such as aluminium, chromium, vanadium and molybdenum would form very hard nitrides when they come in contact with nitrogen. This is made use of in the process of nitriding where alloy steels are case hardened without any quenching process.

9. (b)

Properties depends on basic crystal structure: Density, specific heat, coefficient of thermal expansion, melting points, elastic constants, hardness and ductility.

Properties depends on crystal imperfection: Electrical conductivity, yield stress, creep, fracture strength, semiconductivity, work hardening, fatigue strength.

10. (c)

Zinc → HCP structure

Iron (except in temperature range 910 – 1400°C) → BCC

Iron (910 – 1400°C) → FCC

Copper → FCC

17. (b)

For Rhombohedral crystal systems,

(i) Axial relationship, $a = b = c$

(ii) Interaxial angles, $\alpha = \beta = \gamma \neq 90°$

18. (a)

$$\text{Planer density} = \frac{\text{No. of atoms centered a plane}}{\text{Area of plane}}$$

$$\text{Number of atoms} = 2$$

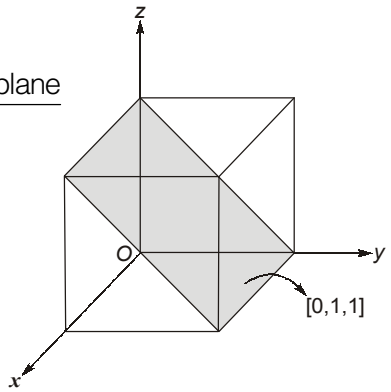
$$= \sqrt{2}\,a \times a$$

$$= \sqrt{2}\,a^2$$

$$\text{Planer density} = \frac{2}{\sqrt{2}\,a^2}$$

$$= \frac{2}{\sqrt{2}\left(\frac{1}{\sqrt{2}} \times 10^{-9}\right)^2}$$

$$= 2\sqrt{2}\ nm^{-2}$$



21. (d)

Applying lever rule,

$$W_\alpha = \frac{0.8-0.45}{0.8-0.02} = \frac{0.35}{0.78} = 0.4487 \approx 44.9\%$$

As density is constant and independent of microcomposition,

$$\rho = \frac{m}{v} = \text{constt.}$$

Volume percentage is same as of mass percentage.

22. (d)

$$\sigma_{steel} = \frac{20\times10^3}{8\times100} = 25 \text{ MPa or } 25 \text{ N/mm}^2$$

$$E_{steel} = \frac{\sigma_{steel}}{E_{steel}} = \frac{25}{200\times10^3} = 1.25\times10^{-4}$$

$$E_{Al} = \frac{\sigma_{Al}}{E_{Al}} \Rightarrow \sigma_{Al} = 1.25\times10^{-4}\times70\times10^3 = 8.75 \text{ N/mm}^2$$

$$A_{Al}(\text{in cm}^2) = \frac{2285.71}{100} = 22.857\text{cm}^2$$

23. (b)

(i) True stress is computed based on necking area or fracture area.

(ii) Load at fracture must be computed from the fracture strength.

$$F = \sigma_f A_O$$

$$= 480\times\frac{\pi}{4}\times(14)^2 = 73890.26\ N$$

$$\text{True stress, } \sigma_T = \frac{F}{A_f} = \frac{4F}{\pi d_f^2}$$

$$= \frac{4\times73890.26}{\pi\times(12.5)^2} = 602.112 \text{ N/mm}^2 \text{ or } 602 \text{ MPa}$$

26. (c)

(i) In an edge dislocation, localized lattice distortion exists along the end of an extra half plane of atoms, which also defines the dislocation line.

(ii) Cross slip is the process when a screw dislocation moves from one slip plane to another.

29. (b)

Ausforming also known as Low and High temperature thermomechanical treatments is a method used to increase the hardness and toughness of an alloy by simultaneously tempering, rapid cooling, deforming and quenching to change its shape and refine the microstructure. This treatment is an important part in the processing of steel.

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