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CLASS TEST

MECHANICAL ENGINEERING

Date of Test : 09/10/2021

ANSWER KEY ➤ Material Science

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

DETAILED EXPLANATIONS

1. (d)

For a ternary system, at constant pressure i.e. N= 1

Gibbs phase rule

$$P + F = C + N$$

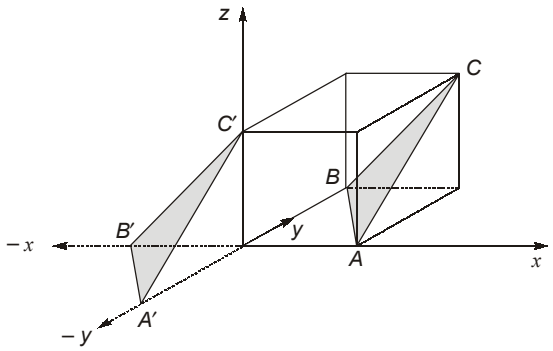
$$P + F = 3 + 1 \qquad \text{(As ternary system} = C = 3\text{)}$$

$$\Rightarrow \quad P = 4 - F$$

If $F = 0$ then number of phases will be maximum.

Maximum no. of phases, $P = 4$

2. (d)



Planes *ABC* and *A′B′C′* are same and plane *A′B′C′* is obtained by shifting *ABC* plane to (–1, – 1,1) co-ordinate which gives miller indices $(\bar{1}\,\bar{1}\,1)$.

4. (c)

In martemperting, steel is heated below the lower critical temperature and is about 600°C.

5. (b)

$$\sigma_T = \sigma_0(1 + e)$$

$$= 300(1.35) = 405 \text{ MPa}$$

7. (b)

Solubility of carbon in austenite is 2%.

10. (b)

In the face centred modification of iron is called austenite or γ-iron. It is the stable form of pure iron at temperatures between 910°C & 1400°C.

11. (a)

Alloy containing 0.8% of Carbon - eutectoid steel

Alloy containing less than 0.8% of Carbon - Hypo eutectoid steel

Alloy containing more than 0.8% Carbon - Hyper eutectoid steel.

12. (d)

Cr → Increases corrosion resistance

Co → Increases Toughness

Mn → Increases Abrasion resistance

Mo → Increases Creep resistance

13. (b)

$$\% \text{ change in density} = \% \text{ change in atomic packing factor}$$

$$= \frac{0.74 - 0.68}{0.68} = 8.8\%$$

17. (d)

Staking faults is a surface defect.

18. (c)

$$L \underset{4.3\%C}{\overset{1150^\circ C}{\rightleftharpoons}} \gamma + Fe_3C \text{ [Eutectic reaction]}$$

19. (b)

Addition of vanadium to steel increases hardenability.

22. (c)

Aluminium has FCC structure,

$$\therefore \quad \text{for FCC, } a = \frac{4r}{\sqrt{2}}$$

$$\frac{a}{r} = \frac{4}{\sqrt{2}} = 2.828$$

23. (a)

Hadfield steel is used for making jaw crusher plate. Its composition is C 1.1 to 1.4%, Mn 11 to 14%, Rest Fe.

24. (d)

For FCC material:

Material	Slip plane	Slip direction	No. of slip system
Cu, Al, Ni, Ag, Au	{111}	< 110 >	12

25. (b)

In screw dislocation motion of dislocation is referred as climb and in edge dislocation movement of dislocation is referred as glide.

In edge dislocation Burger vector is perpendicular to the dislocation line while in screw dislocation Burger vector is parallel to the dislocation line.

Unit plastic deformation is called slip and it always appear in the direction of applied load. Direction of slip is represented by Burger vector.

26. (c)

Cu and Ni are completely soluble in the liquid as well as in solid state.

Ag + Cu and Pb + Sn → These are partially soluble in solid state but fully soluble in liquid state.

27. (d)

$$\text{X-ray wavelength} = \lambda$$

$$\text{Reflection angle, } \theta = 8^\circ \text{ for } n = 1$$

$$\text{Interplanar distance, } d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

$$d_{200} = \frac{a}{\sqrt{2^2 + 0^2 + 0^2}}$$

$$d_{200} = \frac{a}{2}$$

As per Bragg's law,

$$2d\sin\theta = n\lambda$$

$$2 \times \left(\frac{a}{2}\right) \times \sin 8^\circ = 1 \times \lambda$$

$$a = \frac{\lambda}{\sin 8^\circ} = 7.1853\lambda$$

So, lattice parameter, $a = 7.1853\lambda$

28. (d)

In 100 atoms of Cu-Ni alloy, there are 64 atoms of Cu and 36 atoms of Ni.

$$\text{Weight of 64 copper atoms} = \frac{64 \times 63.55}{6.023 \times 10^{23}} \text{gram} = 6.75278 \times 10^{-21} \text{ gram}$$

$$\text{Weight of 36 nickel atoms} = \frac{36 \times 58.69}{6.023 \times 10^{23}} \text{gram} = 3.507953 \times 10^{-21} \text{ gram}$$

$$\text{Weight fraction of copper} = \frac{W_{Cu}}{W_{Cu} + W_{Ni}} = \frac{6.75278 \times 10^{-21}}{6.75278 \times 10^{-21} + 3.507953 \times 10^{-21}}$$

$$= 0.65812$$

$$\text{Weight fraction of copper} = 65.81\%$$

29. (a)

1. Eutectic reaction:

$$L \underset{4.3\%\,C}{\overset{1150^\circ C}{\rightleftharpoons}} \underbrace{\gamma - \text{iron} + Fe_3C}_{\text{Ledeburite}}$$

2. Eutectoid reaction:

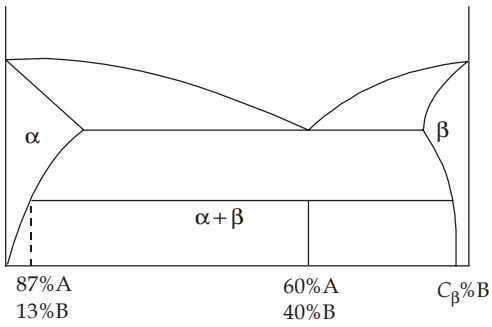
$$\gamma - \text{iron} \underset{0.8\%\,C}{\overset{725^\circ C}{\rightleftharpoons}} \underbrace{\alpha - \text{iron} + Fe_3C}_{\text{Pearlite}}$$

Pealite is having plate like structure of α-iron and Fe_3C. It is phase mixture of α-iron and Fe_3C. It is mainly produced by diffusion.

3. Peritectic reaction:

$$\underbrace{\delta - \text{iron}}_{\text{Solid}} + \underbrace{L}_{\text{Liquid}} \underset{0.18\%\,C}{\overset{1493^\circ C}{\rightleftharpoons}} \underbrace{\gamma - \text{iron}}_{\text{solid}}$$

30. (d)



Given: C_o = 66% α-phase + 34% β-phase

We know that,

$$W_\alpha = \frac{C_\beta - C_O}{C_\beta - C_\alpha}$$

$$0.66 = \frac{C_\beta - 0.40}{C_\beta - C_\alpha} \quad \text{...(i)}$$

$$W_\beta = \frac{C_o - C_\alpha}{C_\beta - C_\alpha}$$

$$0.34 = \frac{0.40 - 0.13}{C_\beta - C_\alpha} \quad \text{...(ii)}$$

Now eq. (i) ÷ (ii):

$$\frac{0.66}{0.34} = \frac{C_\beta - 0.40}{0.27}$$

Composition of *B* is, C_β = (0.92411) = 92.411 wt%B

Composition of *A* in β-phase = 100 – 92.411

Composition of β-phase = 7.589 ≃ 7.59 wt% A

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