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Casting, Welding & Material Science

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CLASS TEST 2019-2020

MECHANICAL ENGINEERING

Casting, Welding & Material Science

Date of Test : 01/06/2019

Answer Key

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

DETAILED EXPLANATIONS

1. (c)

$$\text{Heat generated} = (5500)^2 (250 \times 10^{-6}) (0.15) = 1134.375 \text{ J}$$

If we assume that the material below the electrode is heated enough to melt and fuse, we can calculate the weld nugget volume as;

$$V = \left(\frac{\pi}{4} d^2\right)(t) = \left(\frac{\pi}{4}(6)^2\right)(3) = 84.823 \text{ mm}^3$$

Density for steel is 7850 kg/m^3. Therefore, the weld nugget has a mass of 0.67 g. Since the heat required to melt 1 g of steel is about 1400 J, the heat required to melt the weld nugget is 1400 × 0.67 = 938 J. Consequently, the remaining heat 196.37 J is dissipated into the metal surrounding the nugget.

6. (c)

Strength of the part after compaction is called green strength.

7. (b)

Eutectoid is made of 0.8 % *C*, in iron-iron carbide diagram.

$$\text{Proeutectoid cementite} = \frac{1.4 - 0.8}{6.67 - 0.8} = 0.1022 \simeq 0.10$$

10. (d)

Converging passages are used as spures to gain in velocity of molten metal as it reduces airaspiration.

11. (a)

$$\sigma_T = \sigma_o + K\varepsilon_T^n \quad \text{...(i)}$$

$$\Rightarrow \quad \frac{d\sigma_T}{d\varepsilon_T} = 0 + K \cdot n \cdot \varepsilon_T^{n-1}$$

$$= Kn\varepsilon_T^{n-1} \quad \text{...(ii)}$$

From equation (i)

$$K = \frac{\sigma_T - \sigma_O}{(\varepsilon_T)^n}$$

Substituting the above value in equation (ii)

$$\frac{d\sigma_T}{d\varepsilon_T} = \left(\frac{\sigma_T - \sigma_O}{\varepsilon_T^n}\right)\left(n\,\varepsilon_T^{(n-1)}\right) = \frac{(\sigma_T - \sigma_O)n}{\varepsilon_T}$$

$$= \frac{(300 - 200) \times 0.3}{0.05} = 600 \text{ MPa}$$

12. (d)

Hot chamber die casting is suitable to cast materials which has low melting point. This method is used to cast the alloys of lead, tin and zinc.

This method can also be used for casting Aluminium alloys because the material has a tendency to pick up some iron due to extended contact with the casting equipment.

14. (d)

Surface area of cube = $6l^2$

Surface area of sphere = $4 \pi r^2$

According to Chorinov's relation

$$\text{Solidification time} \propto \left(\frac{\text{volume}}{\text{surface area}}\right)^2$$

as volume of cube and sphere are equal

$$\frac{t_c}{t_s} = \left(\frac{A_s}{A_c}\right)^2 = \left(\frac{4\pi r^2}{6l^2}\right)^2$$

$$\frac{t_c}{t_s} = \left(\frac{4\pi}{6}\right)^2 \left(\frac{r}{l}\right)^4$$

15. (d)

Heat supplied by laser pulse = 0.5 J. Consider, depth of weld be x mm.

Heat consumed = Heat taken to increase the flame + Heat taken to melt the material)

$$0.5 \text{ J} = 0.05x \times \frac{2700}{10^9}\left[896(933-303)+398\times 10^3\right] J$$

[T = 30°C = 303 K]

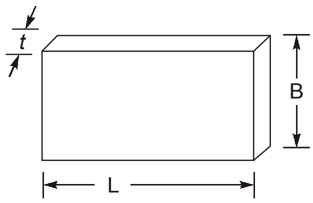
On solving for x, we get

x = 3.84 mm

16. (c)

$$V = L\,B\,t$$

$$A = 2\,[LB + Lt + Bt]$$



Rectangular Slab

$$\frac{V}{A} = \frac{LBt}{2[LB+Lt+bt]}$$

$$\frac{V}{A} = \frac{1}{2\left[\frac{1}{t}+\frac{1}{B}+\frac{1}{L}\right]}$$

for slab, $L >> t$ and $B >> t$,

$$\therefore \quad \frac{V}{A} = \frac{t}{2}$$

Solidification time,

$$T \alpha \left(\frac{V}{A}\right)^2$$

$$\therefore \quad \frac{T_1}{T_2} = \left(\frac{t_1}{t_2}\right)^2$$

or

$$t_2 = t_1\sqrt{\frac{T_2}{T_1}} = 3\sqrt{\frac{4}{2}} = 4.2426 \text{ cm}$$

19. (a)

The power source characteristic can be written analytically as

$$E = 80 - \frac{80}{800}I \qquad \text{(a)}$$

The arc characteristic is given as

$$I = aL + b$$

where a and b are constant

Given,

when $I = 500$ A

then $L = 5.00$ mm

$\therefore$ $500 = 5a + b$ (i)

when $I = 460$ A

then $L = 7.00$ mm

$\therefore$ $460 = 7a + b$ (ii)

Solving Eqs. (i) and (ii), we get

$$a = -20$$

and $b = 600$

Then arc characteristic equation

$$I = -20L + 600 \qquad \text{(b)}$$

from equation (a) and (b)

$$E = 80 - \frac{80}{800}(-20L + 600)$$
$$= 80 - 0.1(-20L + 600)$$
$$= 80 + 2L - 60$$
$$= \mathbf{20 + 2L}$$

20. (c)

$$t = k\left(\frac{V}{A}\right)^2$$

$$\frac{t_1}{t_2} = \left(\frac{V_1}{A_2} \times \frac{A_2}{V_2}\right)^2 = \left\{\left(\frac{d_1}{6}\right)\left(\frac{6}{d_2}\right)\right\}^2$$

$$\frac{t_1}{t_2} = \left(\frac{d_1}{d_2}\right)^2$$

$$\frac{10}{t_2} = \left(\frac{2}{4}\right)^2 = t_2 = 10 \times 4 = 40 \text{ sec}$$

21. (a)

$$\text{Bottom gate, } t_A = \frac{2A}{A_g\sqrt{2g}}\left[\sqrt{h_m} - \sqrt{h_m - H}\right] = 20 \text{ min.}$$

where, $A \rightarrow$ area of mould

A_g = area of gate

According to question, $H = h_m$

$$\Rightarrow \quad t_A = \frac{2A}{A_g\sqrt{2g}}\sqrt{h_m} = 20$$

For top gate, $H = h_m$,

$$\Rightarrow \quad t_B = \frac{A\sqrt{h_m}}{A_g\sqrt{2g}} = \frac{t_A}{2} = 10 \text{ min}$$

22. (a)

d = 200 mm

$\therefore$ r = 100 mm = 0.1 m

$$\text{Solidification time} = k\left(\frac{V}{A}\right)^2$$

$$1078 = k\left(\frac{\frac{4}{3}\times\pi\times(0.1)^3}{4\times\pi\times(0.1)^2}\right)$$

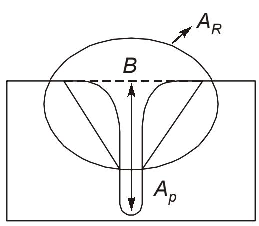
$$k = 1078\times\frac{9}{(0.1)^2} = 0.97 \times 10^6 \text{ s/m}^2$$

28. (c)

A_R - Reinforcement

A_p - Penetration

$$\text{Dilution} = \frac{A_p}{A_p + A_R}$$



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