CLASS TEST

SL. : 04 SP_ME_E+F_15052023

MADE EASY
India's Best Institute for IES, GATE & PSUs

Delhi | Bhopal | Hyderabad | Jaipur | Pune | Bhubaneswar | Kolkata

Web: www.madeeasy.in | E-mail: info@madeeasy.in | Ph: 011-45124612

CASTING + WELDING

MECHANICAL ENGINEERING

Date of Test : 15/05/2023

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)
It also ensures direction solidification, but it's a secondary purpose.

2. (a)
Using modulus method

$$M_R = 1.2M_C$$

For optimum side riser, $d = h$

$$\therefore \quad M_C = \frac{\text{Volume}}{\text{Surface Area}} = \frac{30\times30\times6}{2(30\times30+30\times6\times2)}$$

$$= 2.143 \text{ cm}$$

$$\frac{D}{6} = 1.2 \times 2.143$$

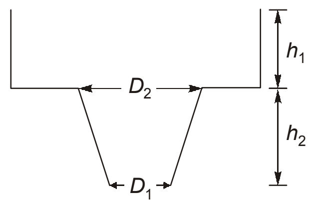
$$D = 6 \times 1.2 \times 2.143$$

$$= 15.43 \text{ cm}$$

3. (b)
$A - 3$, $B - 1$, $C - 4$, $D - 2$.

5. (b)
On increasing currents, heat generated will increase and reducing speed will given more time to heat to accumulate hence increasing weld penetration.

6. (b)



Height of sprue, $h_2 = 18 \text{ cm} = .18 \text{ m}$

$D_2 = 2R_2 = 20 \text{ mm} = .02 \text{ m}$

Height of molten metal in pouring basin, $h_1 = 6 \text{ cm} = .06 \text{ m}$

Total height of molten metal, $h_t = 24 \text{ cm}$

$$\therefore \quad V_2 = \sqrt{2gh_1} = 1.085 \text{ m/s}$$

$$\therefore \quad V_1 = \sqrt{2gh_t} = 2.17 \text{ m/s}$$

$$A_1 = \frac{V_2}{V_1}A_2 = \frac{1.085}{2.17}\times\frac{\pi}{4}\times D_2^2$$

$$\frac{\pi}{4}D_1^2 = \frac{1.085}{2.17}\times\frac{\pi}{4}\times.02^2$$

$$\Rightarrow \quad D_1 = .01414 \text{ m}$$

$$D_1 = 1.414 \text{ cm}$$

7. (a)

$$\text{Volume of weld is} = \frac{\pi}{4}d^2 l$$

d = wire diameter

L = wire feed rate

$$V = \frac{\pi}{4}\times 1.4^2 \times 3.5\times 1000 = 5387.83 \text{ mm}^3/\text{min}$$

$$\text{Area of weld} = \frac{5387.83}{\text{welding speed}} = \frac{5387.83}{160}$$

$$= 33.673 \text{ mm}^2$$

8. (c)

We know that carbon equivalent is

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

More the carbon equivalent, lesser is the weldabiltity of steel.

13. (b)

Number of chaplets required beneath to resist weight of core before pouring.

$$W_C = 800 \times 10^{-6} \times 1500 \times 10 = 12 \text{ N}$$

∴ Atleast 2 chaplets are required, because, each chaplet can withstand a load of 8 N.

$$\text{Buoyancy force} = V_{core}(\rho_m - \rho_c)$$

$$= 800 \times 10^{-6}(6000 - 1500) \times 10$$

$$= 36$$

So, no of chaplets required are:

$$\frac{36}{8} = 4.5$$

Atleast 5 chaplets are required to resist buoyancy force.

14. (b)

$$\text{Heat for melting, } H_m = UV$$

$$V = \frac{\pi}{4}d^2 t = \frac{\pi}{4}(5)^2 \times 2.5 = 49.087 \text{ mm}^3$$

$$\text{Heat supplied, } H_s = 4H_m = 4 \times 9 \times 49.087 = 1767.132 \text{ J}$$

$$H_s = \int_0^t I^2 R dt = \left(10^5\right)^2 \times 100 \times 10^{-6}\int_0^t t^2 dt = \frac{10^6 t^3}{3}$$

$$t = \left(\frac{3\times 1767.132}{10^6}\right)^{1/3} = 0.174 \text{ seconds}$$

15. (d)

Non consumable electrode is used in TIG welding and it is used for welding of Al and Mg alloys in aerospace industries.

16. (c)

$$\text{Heat supplied} = 30000^2 \times 10 \times 10^{-6} \times 0.05 = 450\text{ J}$$

$$\text{Volume of joint} = \frac{\pi \times 5^2 \times 1.5}{4} \simeq 29.452\text{ mm}^3$$

$\therefore$ Heat required for melting is = 29.452 × 10 = 294.52

$\therefore$Heat loss to surround is 450 – 294.52 = 155.48 J

17. (a)

$$\text{For maximum power, voltage}\big|_{\text{generator}} = \frac{\text{open circuit voltage}}{2}$$

and $$\text{current}\big|_{\text{generator}} = \frac{\text{short circuit current}}{2}$$

18. (a)

As neutral flame uses equal amounts of oxygen and acetylene in burning so both cylinders of equal capacity will be emptied together.

19. (b)

For given problem,

Filling time for top gating system = t_{f1}

Since, Height of gating system= Height of mould

$\therefore$ Filling time for bottom gating system = 2 (Filling time for top gating system)

$$\frac{t_{f2}}{t_{f1}} = 2$$

20. (d)

In casting, gating ratio is defined as the ratio of sprue area : runner area : gate area. Therefore, sequence is (iii - i - ii).

21. (c)

$$\text{Choke area} = \frac{m}{\rho \cdot t_s \cdot C_d \cdot \sqrt{2gh_t}} = \frac{\text{Volume}}{t_s \cdot c_d \cdot \sqrt{2gh_t}}$$

$$= \frac{10000}{6 \times 0.9 \times \sqrt{2 \times 1000 \times 500}} = \frac{10000}{6 \times 0.9 \times 1000} = \frac{100}{54} = 1.85\text{ cm}^2$$

22. (c)

- Heat required to melt unit volume is a material property and it will remain same.
- Heat supplied by the source depends on weld speed.

23. (c)

Given: L = 1000 mm, d = 750 mm, k = 2 s/mm^2,

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

$$\left(\frac{V}{A}\right)_{\text{cylinder}} = \frac{\frac{\pi}{4}D^2L}{2 \times \frac{\pi}{4}D^2 + \pi DL} = \frac{D^2L}{2D^2 + 4DL} = \frac{(750)^2 \times 1000}{2(750)^2 + 4 \times 750 \times 1000} = 136.36$$

$$t = \frac{2 \times 136.36^2}{60}$$

$$= 619.83\text{ minutes}$$

24. (c)

Given: $V = 20 + 40L$

Power source characteristic equation can be written as,

$$\frac{V}{V_o} + \frac{I}{I_s} = 1$$

$$\Rightarrow \quad \frac{V}{80} + \frac{I}{1000} = 1$$

$$I = 1000\left(1 - \frac{V}{80}\right) = 1000 - 12.5V$$

$$= 1000 - 12.5(20 + 40L)$$

$$= 1000 - 250 - 500L$$

$$= 750 - 500L$$

$$\text{Power, } P = VI$$

$$= (20 + 40L)(750 - 500L)$$

$$= 20(1 + 2L) \times 250(3 - 2L)$$

$$P = 5000(1 + 2L)(3 - 2L) \text{ W}$$

26. (b)

In casting operation, solidification shrinkage is contraction during phase change from liquid to solid. Solidification shrinkage is compensated by providing riser to the casting.

27. (a)

Energy required for the weld operation = Specific energy × Area of weld bead

$$= 19 \text{ J/mm}^3 \times 20 \text{ mm}^2$$

$$= 380 \text{ J/mm}$$

$$\text{Energy supplied} = VI$$

$$= 120 \times 30$$

$$= 3600 \text{ J/s}$$

$$\eta_{th} = \frac{\text{Energy required}}{\text{Energy supplied}}$$

$$0.70 = \frac{380 \times v}{3600}$$

$$\Rightarrow \quad \text{Weld speed} = 6.6315 \text{ mm/s}$$

28. (c)

$$Z = \frac{L + W}{t}$$

Z = Shape factor, L = Length, W = Width, t = Thickness

$$Z = \frac{35 + 20}{10} = 5.5$$

$$\frac{\text{Riser volume}}{\text{Casting volume}} = 0.35$$

$$\frac{\frac{\pi d^2}{4} \times h}{35 \times 20 \times 10} = 0.35$$

$$\frac{\pi d^3}{4} = 0.35 \times 35 \times 20 \times 10$$

$$d = 14.61 \text{ cm}$$

29. (b)

$$h = 20 \text{ cm}$$
$$A_{base} = 2.5 \text{ cm}^2$$
$$\text{Volume} = 1560 \text{ cm}^3$$

The velocity of the molten metal at the base,

$$v = \sqrt{2 \times 981 \times 20} = 198.1 \text{ cm/s}$$

$$\text{Volumetric flow rate, } Q = A_{base} \times v$$
$$= 2.5 \times 198.1 = 495.227 \text{ cm}^3\text{/s}$$

Time required to fill a mold cavity,

$$t = \frac{\text{Volume}}{Q}$$
$$= \frac{1560}{495.227} = 3.15 \text{ sec}$$

■■■■