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BUILDING MATERIALS

CIVIL ENGINEERING

Date of Test : 28/09/2026

ANSWER KEY ➤

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

DETAILED EXPLANATIONS

1. (a)

2. (d)

Shrinkage of wood during drying is non-uniform in different directions due to its anisotropic structure. The linear shrinkage along the fibres is very small, lying between about 0.1 and 0.3 per cent, whereas shrinkage across the grain is much larger. Radial shrinkage generally lies between 3 and 6 per cent and is generally about 60 per cent of the tangential shrinkage, which ranges from 7 to 12 per cent. As a result, the overall volumetric shrinkage of wood is practically about 1.6 times the tangential shrinkage.

3. (c)

Limes containing 3-5% of clay do not display any hydraulic property and do not set and harden under water. When clay is present as 20-30% of lime, it imparts excellent hydraulic properties.

4. (d)

Concrete is alkaline in nature with an initial pH value of about 12-13, due to the presence of calcium hydroxide in the cement paste, which protects embedded steel from corrosion. In the presence of moisture, carbon dioxide from the atmosphere reacts with calcium hydroxide to form calcium carbonate, a process known as carbonation. This reaction lowers the pH of concrete, and when the pH falls below about 10, the alkaline protection to steel reinforcement is lost, initiating corrosion in the steel reinforcement.

5. (a)

6. (d)

Some examples of accelerators are:

- Sulphates with an exception of calcium sulphate
- Alkali carbonates, aluminates and silicates
- Aluminium chloride, Calcium chloride, Sodium and Potassium hydroxides, Calcium formate, Formaldehyde, Para formaldehyde, etc.

7. (c)

Lime in brick clay has the following effects:

- (i) It reduces the shrinkage on drying.
- (ii) It causes silica in clay to melt on burning and thus helps to bind it.
- (iii) In carbonated form, it lowers the fusion point.
- (iv) If it is present in excess, it causes the brick to melt. The brick loses its shape.
- (v) High lime content can result in buff-burning of bricks.

8. (d)

Portland pozzolana cement is produced by blending Portland cement clinker with pozzolana, which has the ability to react with the calcium hydroxide released during hydration. This reaction forms additional calcium hydrosilicate, thereby reducing the amount of free lime present in the hardened cement paste. As a result, resistance to chemical attack is improved and the cement becomes suitable for marine and aggressive environments. Although the rate of strength development is slower compared to ordinary Portland cement, the ultimate compressive strength of Portland pozzolana cement is comparable.

9. (a)

Cl. 6.2 of IS : 2180 – 1988.

10. (b)

- **Rapid hardening cement:** It is suitable for repairs of roads and bridges and when load is required to be applied in a short period of time.
- **Quick setting portland cement:** It is used when concrete is to be laid under water or in running water.
- **High alumina cement:** It is resistant to the action of fire, sea water, acidic water and sulphates and is used as refractory concrete in industries and is widely used for precasting.
- **Low heat portland cement:** It is most suitable for large mass concrete works such as dams, large raft foundations, etc.

11. (c)

12. (d)

Mica, if present in sand, will reduce the strength of concrete.

13. (d)

An increase in the proportion of tricalcium aluminate (C_3A) in cement leads to very rapid hydration immediately after the addition of water, resulting in high early heat evolution and a tendency towards quick or flash setting. To regulate this rapid reaction, a higher gypsum content is required during grinding. However, increased C_3A content adversely affects durability, particularly by reducing resistance to sulphate attack, making such cement unsuitable for sulphate-rich or mass concrete applications.

14. (b)

Mohs No.	Mineral	Scratch characteristic
1	Talc	Easily scratched with thumb-nail
2	Gypsum	Scratched by thumb-nail
3	Calcite	Not scratched by thumb-nail but easily cut by knife
4	Fluorite	Cut by knife with greater difficulty than calcite
5	Apatite	Cut only with difficulty by knife
6	Orthoclase	Cut with knife with great difficulty on thin edges
7	Quartz	Not scratched by steel; scratches glass
8	Topaz	Scratches quartz
9	Sapphire	Scratches topaz
10	Diamond	Scratches all other minerals

15. (b)

Quick lime is the lime obtained after the calcination of limestone or calcium carbonate.

16. (b)

17. (d)

Wane is a defect that occurs during the conversion of timber when part of the bark or the rounded periphery of the trunk remains on one or more faces of the converted timber. It reduces the effective cross-sectional area of the member and consequently leads to reduction in strength of the affected portion of timber.

18. (a)

- Total quantity of heat evolved is same in both fine and coarse cement.

19. (d)

20. (c)

According to flexure test,

$$\text{Modulus of rupture} = \frac{Pl}{bd^2} \quad (a > 200 \text{ mm})$$

$$= \frac{3Pa}{bd^2} \quad (200 \text{ mm} > a > 170 \text{ mm})$$

$$\text{For } a = 180 \text{ mm, modulus of rupture} = \frac{3 \times 20 \times 10^3 \times 180}{150 \times 150^2} = 3.2 \text{ N/mm}^2$$

21. (b)

- Sulphate of calcium, magnesium, sodium, potassium or iron usually found in bricks in small proportions are harmful substances in brick earth.
- If sufficient time is not given for burning of brick then carbon and sulphur which are present in brick will not get oxidize properly and results in formation of spongy, swollen structure in brick and the brick will be decoloured by white patches.

22. (d)

- Polyether polycarboxylate is superplasticizer.

23. (c)

Water absorbed by coarse aggregate (CA) = 2%

$$\therefore \text{Water absorbed} = 1350 \times \frac{2}{100} = 27 \text{ kg}$$

Similarly, water absorbed by fine aggregate (FA)

$$= 500 \times \frac{0.5}{100} = 2.5 \text{ kg}$$

$\therefore$ Quantity of CA should be decreased by 27 kg and quantity of FA should be decreased by 2.5 kg.

$$\text{Total water absorbed} = 27 + 2.5 = 29.5 \text{ kg}$$

$\therefore$ Total water should be increased by 29.5 kg per m^3 of concrete.

24. (d)

Let $\frac{\text{Fine aggregate}}{\text{Coarse aggregate}} = x$

So, combined aggregate/coarse ratio will be $(1 + x)$

$$\Rightarrow (1 + x)6 = 1 \times 7.5 + x \times 2.8$$

$$\Rightarrow x = \frac{7.5 - 6}{6 - 2.8} = 0.468 \text{ or } 46.8\%$$

25. (a)

For ordinary concrete, maturity should not be less than 19800°C-hrs .

If the period of wait after the concrete is placed before removing or stripping the forms is t days, then the maturity at the given strength of 21 MPa at average curing temperature of 7°C is

$$M = (T - T_0) \times \Delta t$$

where M = Maturity in $^\circ\text{C-hours}$ (or $^\circ\text{C-days}$)

T = Average concrete temperature, $^\circ\text{C}$, during each time interval, Δt

T_0 = Datum temperature (typically taken to be -11°C)

Δt = Time intervals (hours or days)

$$\therefore M = \{7 - (-11)\} \times t$$

$\therefore$ To achieve minimum desired concrete maturity of 19800°C-hrs

$$M = \{7 - (-11)\} t = 19800$$

$$\Rightarrow t = 1100 \text{ hrs}$$

$$\Rightarrow t = 45.833 \text{ days} \simeq 46 \text{ days}$$

26. (a)

27. (b)

Assuming 1 ml of cement on hydration produces 2.06 ml of gel.

$$\text{Volume of gel} = C \times 0.319 \times 2.06 = 0.657 C$$

$$\text{Space available} = C \times 0.319 + W_o$$

$$\text{Gel space ratio} = \frac{0.657C}{0.319C + W_o}$$

28. (a)

For 1 m^3 of concrete, $1 = \frac{W_C}{\rho_C} + \frac{W_{CA}}{\rho_{CA}} + \frac{W_W}{\rho_W} + \frac{W_{FA}}{\rho_{FA}}$

$$\Rightarrow 1 = \frac{480}{3.2 \times 10^3} + \frac{1100}{2.65 \times 10^3} + \frac{W_W}{10^3} + \frac{520}{2.6 \times 10^3}$$

$$\Rightarrow 10^3 = 150 + 415.094 + W_W + 200$$

$$\Rightarrow W_W = 234.906 \text{ kg} \simeq 234.9 \text{ kg}$$

29. (c)

A fibre reinforced concrete requires a considerably greater amount of fine aggregates than that of conventional concrete for convenient handling. For FRC to be fully effective, each fibre needs to be fully embedded in the matrix, thus the cement paste requirement is more.

30. (c)

Rapid hardening Portland cement is produced by increasing the C_3S content of the clinker and by finer grinding compared to ordinary Portland cement. Consequently, rapid hardening cement is able to attain compressive strength in about three days that is comparable to the seven days strength of ordinary Portland cement, making it suitable for works where early strength is required.

