CLASS TEST

S.No.:01SKCE_ABCD_10062025

MADE EASY

Leading Institute for IES, GATE & PSUs

Delhi | Bhopal | Hyderabad | Jaipur | Pune | Kolkata

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

Environment Engineering

CIVIL ENGINEERING

Date of Test : 10/06/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (b)

$$\Rightarrow \quad TH = Ca^{2+} \text{ as } CaCO_3 + Mg^{2+} \text{ as } CaCO_3$$

$$= \frac{120}{20}\times 50 + \frac{48}{12}\times 50 = 500 \text{ mg/l as } CaCO_3$$

$$\text{Alkalinity} = [HCO_3^-] \text{ as } CaCO_3$$

$$= \frac{183}{61}\times 50 = 150 \text{ mg/l as } CaCO_3$$

$$CH = \min(TH, \text{Alkalinity}) = 150 \text{ mg}/l$$

$$NCH = TH - CH = 350 \text{ mg}/l$$

2. (a)

$$\text{Total organic loading rate} = 300 \times (1 - 0.3) \times 6 \text{ kg/day}$$

$$y = 1260 \text{ kg/day}$$

$$F = 2$$

$$V = 2000 \text{ m}^3 = 0.2 \text{ ha-m}$$

$$\eta = \frac{100}{1+0.0044\sqrt{\frac{y}{VF}}} = \frac{100}{1+0.0044\sqrt{\frac{1260}{2\times 0.2}}}$$

$$\eta = 80.2\%$$

3. (b)

$$Q = 10 \text{ m}^3/\text{sec}$$

$$v_d = 2 \times 10^5 \times (1 \times 10^{-6}) = 0.2 \text{ m/sec}$$

$$\eta = 1 - e^{-\left(\frac{Av_d}{Q}\right)}$$

$$0.90 = 1 - e^{-\left(\frac{Av_d}{Q}\right)}$$

$$e^{-\left(\frac{Av_d}{Q}\right)} = 0.1$$

$$-\frac{AV_d}{Q} = \ln(0.1) = -\ln 10 = -2.303$$

$$\Rightarrow \quad A = 115.13 \text{ m}^2$$

4. (a)

$$Q = \frac{2\pi T(S_1 - S_2)}{\ln\left(\frac{r_2}{r_1}\right)}$$

$$T = \frac{Q\ln\left(\frac{r_2}{r_1}\right)}{2\pi(S_1 - S_2)} = \frac{5000\times 24\times 60\times 10^{-3}\ln\left(\frac{200}{20}\right)}{2\pi(4-1)}$$

$$T = 879.5 \text{ m}^2/\text{day} \simeq 880 \text{ m}^2/\text{day}$$

5. **(d)**

Catabolism is destructive phase of metabolism.

6. **(a)**

$$[pH]_A = 5.5$$

$$\Rightarrow \quad [H^+]_A = 10^{-5.5} \text{ and } [OH^-]_A = 10^{-(14-5.5)}$$

$$[OH^-]_A = 10^{-8.5}$$

$$[OH^-]_B = 20[OH^-]_A = 20 \times 10^{-8.5} = 2 \times 10^{-7.5}$$

$$\Rightarrow \quad [H^+]_B = \frac{10^{-14}}{2\times 10^{-7.5}} = \frac{10^{-6.5}}{2}$$

$$[pH]_B = -\log\left[\frac{10^{-6.5}}{2}\right]$$

$$= 6.5 + \log 2$$

$$= 6.5 + 0.3$$

$$[pH]_B = 6.8$$

7. **(b)**

$$\underset{56g}{CaO + H_2O} \rightarrow \underset{74\ g}{Ca(OH)_2}$$

$$\underset{27\,g}{FeSO_4 7H_2O} + \underset{74\,g}{Ca(OH)_2} \rightarrow Fe(OH)_2 + CaSO_4 + 7H_2O$$

$$\frac{8\,mg}{l}\ \frac{74\times 8}{278} = 2.13\ mg/l$$

Quantity of quicklime for 592 mg/l of $Ca(OH)_2$.

$$= \frac{56}{74}\times 2.13\ mg/l = 1.612\ mg/l$$

For $10 \times 10^6\ l$ of water $= 16.12$ kg

8. **(d)**

$$SVI = \frac{V_{ob}\,(ml/l)}{X_{ob}\,(mg/l)} = \frac{V_{ob}}{X_{ob}}\times 100\ ml/g$$

V_{ob} = Settled volume sludge per liter

$$= \frac{850}{2} = 425\ ml/l$$

$$V_{ob} = 3000\ mg/l$$

$$SVI = \frac{425}{3000}\times 1000 = 141.667 \simeq 142\ ml/g$$

9. **(b)**

$$S = \frac{Q_S S_S + Q_R S_R}{Q_S + Q_R}$$

$$\Rightarrow \quad 20 = \frac{10(350) + Q_R(5)}{10 + Q_R}$$

$$\Rightarrow \qquad Q_R = 220 \text{ MLD}$$

$$\Rightarrow \qquad Q_R = \frac{220\times10^6}{86400}$$

$$\Rightarrow \qquad Q_R = 2546.30 \text{ lit/sec} \simeq 2546 \text{ lit/sec}$$

10. (d)

Statement I is false but II is true.

Coliforms are rod-shaped non-pathogenic bacteria.

11. (a)

$$k = \frac{[H^+][CO_3^{2-}]}{[HCO_3^-]}$$

$$[H^+] = 10^{-10} \text{ M}$$

$$[CO_3^{2-}] = \frac{30\times10^{-3}}{60} M = 5\times10^{-4} \text{M}$$

$$5\times10^{-11} = \frac{10^{-10}\times5\times10^{-4}}{[HCO_3^-]}$$

$$[HCO_3^-] = 10^{-3} \text{ M]}$$

$$[HCO_3^-] \text{ in mg}/l = 61\times10^{-3}\times10^{3} = 61 \text{ mg}/l$$

$$\text{Bi-carbonate alkalinity} = \frac{61}{61}\times50 = 50 \text{ mg}/l \text{ as } CaCO_3$$

12. (c)

$$\text{DO of mix} = \frac{9.2\times2+0.3\times0}{2+0.3} = 8 \text{mg}/l$$

$$D_0 = 9.2 - 8 = 1.2 \text{ mg}/l$$

$$BOD_u = 1.25\ BOD_5 = 250 \text{ mg}/l$$

$$F = 3$$

$$L = \frac{0\times2+0.3\times250}{2+0.3}$$

$$L = 32.609 \text{ mg}/l$$

$$\left(\frac{L}{D_c F}\right)^{f-1} = f\left[1-(f-1)\frac{D_0}{L}\right]$$

$$\left[\frac{32.609}{D_C\times3}\right]^2 = 3\left[1-\frac{2\times1.2}{32.609}\right]$$

$$D_C = 6.52 \text{ mg/l}$$

$$\text{Minimum } DO = 9.2 - 6.52 = 2.68 \text{ mg}/l \simeq 2.7 \text{ mg}/l$$

13. (d)

$$r = 15\%$$
$$r' = 2\%$$
$$P_{2021} = 2{,}00{,}0000$$
$$P_{2031} = P_{2021} + \left(\frac{r - r'}{100}\right) \times P_{2021}$$
$$= 200000 + \left(\frac{15-2}{100}\right) \times 200000 = 2{,}26{,}000$$
$$P_{2041} = P_{2031} + \left(\frac{r - 2r'}{100}\right) P_{2031}$$
$$= 226000 + \left(\frac{15-4}{100}\right) \times 226000$$
$$P_{2041} = 250860$$

14. (a)

Grit chambers are mainly constructed to prevent the accumulation of inorganic particles in sludge digesters.

15. (b)

$$k = \frac{[\text{HOCl}]}{\left[\text{H}^+\right]\left[\text{OCl}^-\right]}$$

Here concentration is in moles/litre

$$10^{7.4} = \frac{[\text{HOCl}]}{\left[10^{-7.4}\right]\left[\text{OCl}^-\right]}$$

$\Rightarrow$ $[\text{HOCl}] = [\text{OCl}^-]$

Free residual chlorine $= [\text{HOCl}] + [\text{OCl}^-]$

$\Rightarrow$ $\dfrac{2 \times 10^{-3}}{2 \times 35} = [\text{HOCl}^-] + [\text{OCl}^-]$

$\Rightarrow$ $2.857 \times 10^{-5} = 2[\text{OCl}^-]$

$\Rightarrow$ $[\text{OCl}^-] = 1.429 \times 10^{-5}$ moles/litre

$\Rightarrow$ $[\text{OCl}^-] = 1.429 \times 10^{-5} \times 51 \times 10^{3}$ mg/l

$\Rightarrow$ $[\text{OCl}^-] = 0.729$ mg/l

16. (d)

TS + SS → DS

	Test sample	Seeded sample	Diluted sample
	5 mL	295 mL	300 mL
Initial DO:	5 mg/l	7 mg/L	x
Final DO:	-	-	y

$$x = \frac{5 \times 5 + 7 + 295}{300} = 6.967 \text{ mg}/l$$

Also, $x - y = 6.967$ (after 5 days of incubation)

$\Rightarrow$ $y = 0 \text{ mg}/l$

$\because$ Final DO of diluted sample is zero.

Hence, the readings should be discarded.

17. **(c)**

Relative stability for a sample is given by,

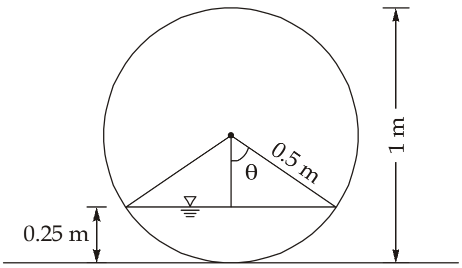
$$s = \frac{O_2 \text{ available in effluent}}{\text{Total } O_2 \text{ required for 1st stage BOD}}$$

Carbonaceous demand (1st stage BOD) = Total oxygen demand – Nitrogenous demand

$= 110 - 60 = 50 \text{ mg}/l$

$\therefore$ $$s = \frac{40}{50} \times 100 = 80\%$$

18. **(b)**



$$\cos\theta = \frac{0.5 - 0.25}{0.5} = \frac{0.25}{0.5} = \frac{1}{2}$$

$\Rightarrow$ $$\theta = \frac{\pi}{3}$$

Cross-sectional area of flow, $$A = r^2\left[\theta - \frac{\sin 2\theta}{2}\right]$$

$\Rightarrow$ $$A = (0.5^2)\left[\frac{\pi}{3} - \left\{\sin\left(2 \times \frac{\pi}{3}\right)\right\}\frac{1}{2}\right]$$

$\Rightarrow$ $$A = \frac{1}{4}\left[\frac{\pi}{3} - \frac{\sqrt{3}}{4}\right]$$

$$A = 0.1535 \text{ m}^2$$

Wetted perimeter of flow $= r(2\theta)$

$$= 0.5 \times 2 \times \frac{\pi}{3} = 1.047 \text{ m}$$

$\therefore$ Hydraulic radius $$= \frac{A}{P} = \frac{0.1535}{1.047} = 0.147 \text{ m}$$

19. (c)

$$\text{Concentration of gas} = 2.8 \text{ ppm}$$

$\Rightarrow 10^6$ m^3 air holds 2.8 m^3 gas

$\Rightarrow 1$ m^3 air holds 2.8×10^{-6} m^3 gas

$\because$ Ideal gas law is valid, $\therefore$ $PV = nRT$

$$P = 2 \text{ atm}$$
$$V = 2.8 \times 10^{-6} \text{ m}^3$$
$$T = 294 \text{ K}$$
$$R = 82.05 \times 10^{-6} \text{ atm m}^3/\text{mol. K}$$

$\therefore$ $2 \times 2.8 \times 10^{-6} = n \times 82.05 \times 10^{-6} \times 294$

$$n = 2.32146 \times 10^{-4} \text{ mol}$$

(Note: The concentration is asked in 1 m^3 of air)

$\therefore$ $n = 2.32146 \times 10^{-4} \times (10^{-2} \times 10^{2})$

$\Rightarrow$ $n = 2.32146 \times 10^{2}\ \mu$ mol

$\Rightarrow$ $n = 232.146\ \mu$ mol

$\Rightarrow 1$ m^3 of air has 232.146 ($\simeq$ 232.15) μ mol of gas.

20. (d)

River	Waste water
$Q_R = 60 \text{ m}^3/\text{s}$	$Q_w = 6 \text{ m}^3/\text{s}$
DO = 7 mg/l	DO = 0 mg/l
$BOD_5 = 9$ mg/l	$BOD_5 = 210$ mg/l

Given data: $k_D = 0.5/\text{day}$

$$k_R = 1/\text{day}$$

$$(DO)_{sat} = \frac{7}{0.8} = 8.75 \text{ mg}/l$$

$$(DO)_{mix} = \frac{60 \times 7 + 6 \times 0}{66} = 6.364 \text{ mg}/l$$

$$(BOD_5)_{mix} = \frac{60 \times 9 + 6 \times 210}{66} = 27.273 \text{ mg}/l$$

$$\text{Initial DO deficit } (D_0) = 8.75 - 6.364 = 2.386 \text{ mg}/l$$

$$\text{Ultimate BOD } (L_0) = \frac{(BOD_5)_{mix}}{1 - e^{-0.5 \times 5}} = \frac{27.273}{1 - e^{-2.5}} = 29.71 \text{ mg}/l$$

Min DO occurs at critical time t_c where,

$$t_c = \frac{1}{k_R - k_D} \ln\left[\frac{k_R}{k_D}\left\{1 - D_0 \times \left(\frac{k_R - k_D}{k_D L_0}\right)\right\}\right]$$

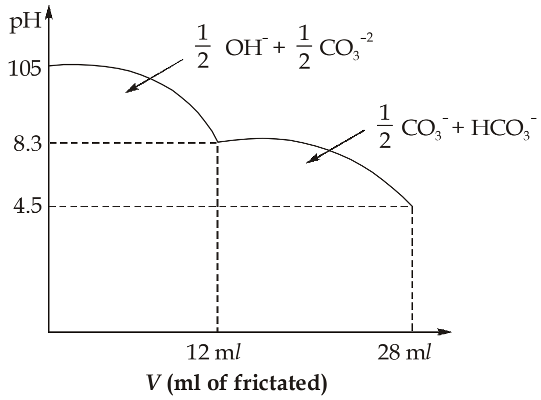
$\Rightarrow$
$$t_c = \frac{1}{1 - 0.5} \ln\left[\frac{1}{0.5}\left\{1 - 2.386 \times \left(\frac{1 - 0.5}{0.5 \times 29.71}\right)\right\}\right]$$

$\Rightarrow$ $t_c = 1.219$ days

$\therefore$ Distance of critical DO deficit $= V \times t_c$

$$= \frac{1 \times 1.219 \times 86400}{1000} \text{ km} = 105.3 \text{ km}$$

21. (d)



As per graph

12 ml of 0.02 NH_2SO_4 is used to neutralize alkalinity due to $\frac{1}{2}CO_3^{-2} + OH^-$

i.e. in given 200 m*l* water sample, alkanity due to $\frac{1}{2}CO_3^{-2} + OH^-$ is 12 mg

$\therefore$ In 1000 m*l* of water sample, alkanity due to $\frac{1}{2}CO_3^{-2} + OH^-$ is $\frac{12}{250} \times 1000$ = 48 mg/lit

$$\therefore \quad \frac{1}{2}CO_3^{-2} + OH^- = 48 \text{ mg/lit as } CaCO_3 \quad ...(1)$$

Now,

$$pH = 10.5$$

$$\therefore \quad pOH = 14 - 10.5 = 3.5$$

Now $\quad pOH = -\log[OH^-]$

$$\Rightarrow \quad 3.5 = -\log[OH^-]$$

$$\Rightarrow \quad [OH^-] = 10^{-3.5} \text{ mole/lit}$$

$$\because \quad \text{No. of mole} = \frac{\text{Weight}}{\text{Molecular weight}}$$

$$\Rightarrow \quad 10^{-3.5} = \frac{\text{Weight}}{17}$$

$$\Rightarrow \quad OH^- = 17 \times 10^{-3.5} \text{ gm}$$

$$\therefore \quad \text{Number of gm. eq.} = \frac{\text{Given weight}}{\text{Equivalent weight}} = \frac{17 \times 10^{-3.5}}{(17/1)} = 10^{-3.5} \text{ gm eq.}$$

$\therefore$ Alkanity due to OH^- in terms of $CaCO_3$ = $10^{-3.5} \times 50 \times 1000$ = 15.81 mg/lit. as $CaCO_3$

Put in eq. (1),

Alkanity due to carbonate = (48 – 15.81) × 2 = 64.38 mg/lit. as $CaCO_3$

22. (b)

$$Q = 50000\ m^3/day$$

$$t_d = 30\ s$$

$$\text{Volume of tank} = Q\ t_d$$

$$= \frac{50000}{86400} \times 30 = 17.361\ m^3$$

We know $P = \mu V G^2$

$\Rightarrow$ $P = 10^{-3} \times 17.361 \times (800)^2$

$$P = 11111.04\ \text{Watt} = \frac{11111.04}{746} = 14.894\ hp$$

$\because$ Shaft and motor are not 100% efficient i.e., they are efficient 80% and 90% respectively

$\therefore$ $$P = \frac{14.894}{0.90 \times 0.80} = 20.686\ hp \simeq 20.7\ hp$$

23. (c)

We know $$1\ \mu g/m^3 = \frac{1\,\text{ppm} \times \text{molecular mass of pollutant}}{l/\text{mole of pullutant at given temperature and pressure}} \times 10^3\ l/m^3 \quad ...(1)$$

The value of l/mol (i.e. volume, in litres occupied by one molecule of pollutant gas) at 0°C and 1 atm pressure (i.e. 760 mm Hg) is equal to 22.4.

At other value of temperature and pressure, its value is governed by

Avagardor's law as: $$\frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2}$$

V_1 = Volume at 0°C of 1 atm pressure i.e. 22.4 l/mol

P_1 = 760 mm Hg

T_1 = 0°C = 273 K

$\therefore$ $$\frac{22.4 \times 760\,\text{mm of Hg}}{273°\text{K}} = \frac{V_2 \times 760\,\text{mm of Hg}}{(273° + 20°)\text{K}}$$

$\Rightarrow$ $$V_2 = 22.4 \times \frac{293}{273} = 24.04\ l/\text{mol}$$

Put in eq.(1)

$$1\ \mu g/m^3 = \frac{1\,\text{ppm} \times 64}{24.04} \times 10^3$$

$\therefore$ $$60\ \mu g/m^3 = \frac{SO_2\ \text{in ppm} \times 64 \times 10^3}{24.4}$$

$\Rightarrow$ SO_2 in ppm = 0.023 ppm

24. (b)

Treated water = 25000 m^3/day

or 25000×10^3 lt/day = 25 MLD

Required chlorines per day = 10 kg/day

Chlorine required per litre = $\frac{10\times10^6}{25\times10^6}=0.4$ mg/lt.

The residual Cl_2 left = 0.22 mg/lt.

So, chlorine demand = 0.4 – .22 = 0.18 mg/lt.

Chlorine demand per day = $0.18 \times 25 \times 10^6 \times 10^{-6}$

= 4.5 kg/day

25. (d)

Given, $L_e = 1.5$ L

$$\frac{L_e}{L} = \frac{1-\eta}{1-\eta_e}$$

(η = Porosity)

$$1.5 = \frac{1-0.4}{1-\eta_e}$$

$$\eta_e = 0.6$$

$$V_s = \frac{(G-1)gd^2}{18\nu} = \frac{(2.65-1)\times981\times(0.066)^2}{18\times1.31\times10^{-2}}$$

$$V_s = 29.9 \text{ cm/sec}$$

$$\eta_e = \left(\frac{\bar{V}_s}{V_s}\right)^{0.22}$$

($\bar{V}_s$ = Backwash velocity)

$$0.6 = \left(\frac{\bar{V}_s}{29.9}\right)^{0.22}$$

$$\bar{V}_s = 2.933 \text{ cm/sec}$$

26. (a)

Total mass (solid + water) = 100 kg

Total moisture =

$$\frac{1}{100}(15\times6+24+6+33\times5+4.2\times0.5+0.49\times2+0.13\times0.5$$
$$+1.18+0.5+0.35\times0.5+17.97+60+1.67+6+2.01\times8)$$

= 15.9739 kg

Mass of solids = 100 – 15.9739 = 84.0261 kg

Total moisture (on dry basis) = $\frac{\text{Mass of water}}{\text{Mass of solids}} = \frac{15.9739\times100}{84.0261} = 19.01\%$

27. **(d)**

Sample size (1 m*l*)

$$\text{Number of positive tubes} = \frac{288}{360} \times 5 = 4$$

Sample size (0.1 m*l*)

$$\text{Number of positive tubes} = \frac{144}{360} \times 5 = 2$$

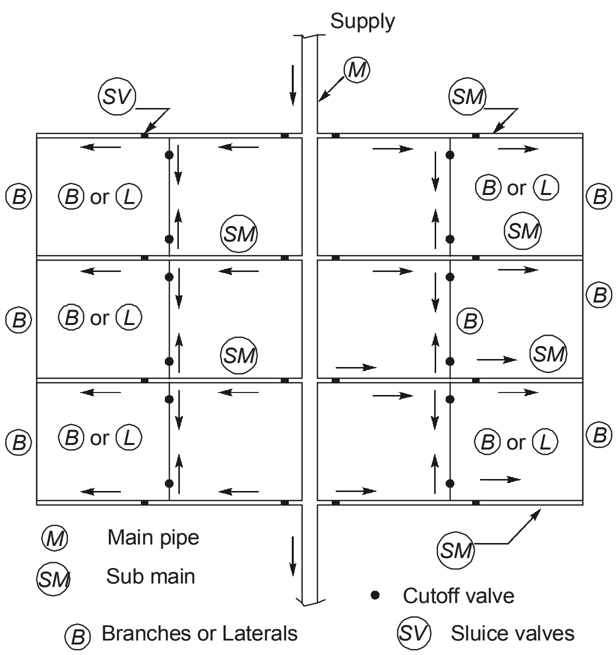
Sample size (0.01 m*l*)

$$\text{Number of positive tubes} = \frac{72}{360} \times 5 = 1$$

Positive combination is 4 - 2 - 1 and negative combination is 1 - 3 - 4.
But dilution of standard used is 10 m*l*, 1 m*l*, 0.1 m*l*.
So, MPN index for negative results = 38 × 10 = 380

28. **(c)**

Statement 2: Sonoscope is used for detection of leakage in underground water mains.
Statement 3: In grid system, one main pipe runs through centre and branches and laterals run in grid pattern which are interconnected.



29. **(b)**

Let x g of NaOH be added to solution to change pH from 7 to 9.

$$(pOH)_{initial} = 14 - 7 = 7$$
$$(pOH)_{final} = 14 - 9 = 5$$
$$[OH^-]_{initial} = 10^{-7} \text{ mol/lt.}$$
$$[OH^-]_{final} = 10^{-5} \text{ mol/lt.}$$

According to question,
For 1 litre of solution

$$\frac{x}{40} + 10^{-7} = 10^{-5} \qquad \text{(Molecular weight of NaOH = 40 g/mol)}$$

$$\Rightarrow \quad \frac{x}{40} = 10^{-5} - 10^{-7} = 99 \times 10^{-7}$$

$$\Rightarrow \quad x = 99 \times 40 \times 10^{-7} \text{ g}$$

$$x = 99 \times 4 \text{ μg}$$

$$= 396 \text{ μg}$$

∴ 396 μg/l of NaOH is required to change pH from 7 to 9.

30. (a)

Component	**% by mass**	**% Moisture**	**Energy (kJ/kg)**	**Dry (mass (kg))**	**Total Energy (kJ)**
Food waste	20	70	4650	6	93000
Paper	40	6	16750	37.6	670000
Card board	15	5	16300	14.25	244500
Plastics	7.5	2	32600	7.35	244500
Garden trimming	7.5	60	6500	3	48750
Wood	5	20	18600	4	93000
Tin cans	5	3	700	4.85	3500
Total				77.05	

$$\text{Moisture content} = \left(\frac{100 - 77.05}{100}\right) \times 100 = 22.95\%$$

$$\text{Unit energy content} = \frac{\text{Total energy}}{\text{Total weight}} = \frac{1397250}{100} = 13972.50 \text{ kJ/kg}$$

∴ Energy content on ash-free dry basis

$$= 13972.50\left(\frac{100}{100 - 22.95 - 5}\right) = 19392.78 \text{ kJ/kg}$$

■■■■