CLASS TEST

S.No.: 01DKSK_ABCDEFGH_31726

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IC ENGINE

MECHANICAL ENGINEERING

Date of Test : 31/07/2026

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (b)

2. (d)

$$\text{Initial efficiency, } \eta_i = 1-\frac{1}{(r)^{\gamma-1}} = 1-\frac{1}{(10)^{0.4}} = 0.60189$$

$$\eta_i = 60.19\%$$

When γ decreases by 1.5%, value of new γ is:

$$\gamma_n = 1.4\times\frac{(100-1.5)}{100} = 1.379\,\%$$

New efficiency is

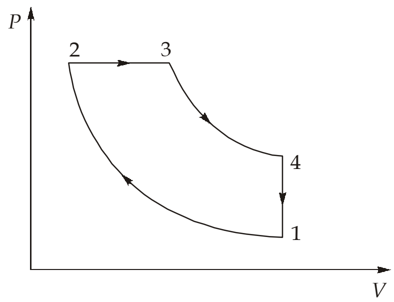
$$\eta_f = 1-\frac{1}{(r)^{\gamma_n-1}} = 1-\frac{1}{(10)^{0.379}} = 0.5822$$

$$\eta_f = 58.22\%$$

$$\text{So, change in efficiency is } = \frac{58.22-60.19}{60.19} = -0.0327 = -3.27\%$$

Efficiency decreases by 3.27%.

3. (c)



$$\frac{V_3}{V_2} = r_c = 2$$

$$V_3 = V_2 + 0.05 \times V_S$$

$$(V_3 - V_2) = 0.05 \times (V_1 - V_2)$$

$$\left(\frac{V_3}{V_2}-1\right) = 0.05\left(\frac{V_1}{V_2}-1\right)$$

$$(2 - 1) = (0.05)(r - 1) \qquad \left(\text{where r is compression ratio } = \frac{V_1}{V_2}\right)$$

$$r = 21$$

We know that,

$$\eta = 1-\frac{1}{(r)^{\gamma-1}}\frac{\left(r_c^{\gamma}-1\right)}{\gamma\left(r_c-1\right)}$$

$$= 1-\frac{1}{(21)^{1.4-1}}\frac{\left(2^{1.4}-1\right)}{1.4(2-1)} = 0.6536 = 65.36\%$$

4. (b)

$$\frac{0.86}{12}C+\frac{0.14}{2}H_2 + x(O_2 + 3.76N_2) = aCO_2 + bH_2O + cN_2$$

By comparing:

$$a = 0.07166$$
$$b = 0.07$$
$$c = x \times 3.76$$
$$x = a+\frac{b}{2} = 0.10666$$
$$c = 0.40104$$
$$\% \text{ of } CO_2 = \frac{a}{a+c} = \frac{0.07166}{0.07166+0.40104} = 0.15159 = 15.16\%$$

Note: for dry exhaust gas, H_2O will not be counted.

5. (c)

in case of Compression-Ignition Engines mixture preparation occur inside engine cylinder.

6. (c)

With the perfect regenerator the Ericsson cycle efficiency is equal to Carnot. Therefore the lowest efficiency for the given temperature limits is of Otto cycle.

7. (d)

$$BP = \frac{2\pi NT}{60\times1000} = 2 \times 3.14 \times 3000 \times \frac{20}{(60\times1000)} = 6.28 \text{ kW}$$

$$BMEP = \frac{BP\times2\times60}{Vs\times N\times K\times100}(\text{bar})$$

$$\text{Swept volume, } Vs = \frac{\pi\times0.1^2\times0.1}{4} = 0.000785 \text{ m}^3$$

$$\text{BMEP} = 6.28 \times 2 \times \frac{60}{(0.000785\times3000\times1\times100)} = 3.2 \text{ bar}$$

8. (b)

Given: At full load, IP = 80 kW, η_{bth} = 40%

At 75% load, $(\eta_m)_{@75\%} = 60\% = 0.60$

and frictional power constant (i.e. FP)

We know, $$(\eta_m)_{@75\%\text{ load}} = \frac{0.75BP}{0.75BP+FP}$$

$$0.6 = \frac{0.75BP}{0.75BP+FP}$$

$\Rightarrow$ $$\text{BP} = 2\text{FP} \quad \text{... (i)}$$

Now, at full load, $\text{IP} = \text{BP} + \text{FP}$

From equation (i), we get

$$80 = 2\text{FP} + \text{FP}$$

$$\text{FP} = \frac{80}{3}\text{kW}$$

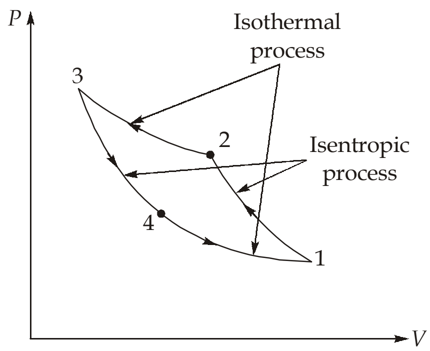
$\therefore$ $$\text{BP} = \frac{160}{3}\text{kW}$$

Now, at half load

$$(\eta_m)_{@50\%\text{ load}} = \frac{0.5BP}{0.5BP + FP} = \frac{0.5\left(\frac{160}{3}\right)}{0.5\left(\frac{160}{3}\right) + \frac{80}{3}} = 0.50 = 50\%$$

9. (b)

$$\text{COP} = \frac{T_0}{T_k - T_0} = \frac{1}{\frac{T_k}{T_0} - 1}$$



where, $T_2 = T_3 = T_k$

$T_4 = T_1 = T_0$

As, 1-2 isentropic compression

So, $$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\frac{T_k}{T_0} = (r)^{\gamma - 1} \qquad \text{where, } \left[\frac{V_1}{V_2} = r\right]$$

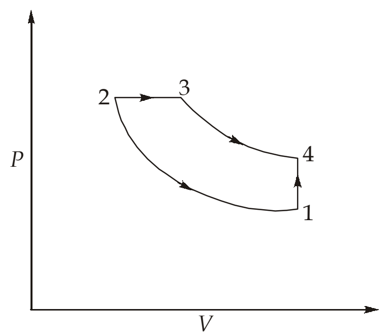
So, $$\text{COP} = \frac{1}{(r)^{\gamma-1} - 1}$$

Given, $\text{COP} = 2$

So, $$2 = \frac{1}{(r)^{\gamma-1} - 1}$$

$r = 2.76$

10. (b)



Compression ratio, $r = \dfrac{V_1}{V_2} = 15$

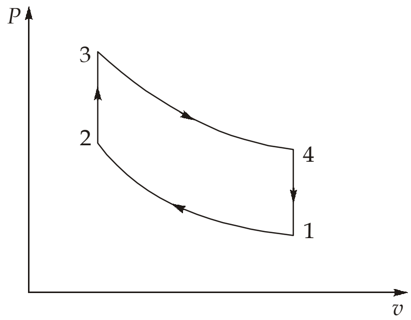
Expansion ratio, $r_e = \dfrac{V_4}{V_3} = 10$

Cut-off ratio, $r_c = \dfrac{r}{r_e} = \dfrac{V_1/V_2}{V_4/V_3} = \dfrac{V_3}{V_2} = \dfrac{15}{10} = 1.5$ $\qquad [V_1 = V_4]$

Air standard efficiency, $$\eta = 1 - \frac{1}{\gamma}\frac{1}{r^{\gamma-1}}\left[\frac{r_c^{\gamma} - 1}{r_c - 1}\right] = 1 - \frac{1}{1.4} \times \frac{1}{15^{0.4}}\left[\frac{1.5^{1.4} - 1}{1.5 - 1}\right]$$

$= 0.6305 = 63.05\%$

11. (d)



$$T_1 = 27 + 273$$
$$T_1 = 300 \text{ K}$$
$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma}$$
$$\frac{T_2}{T_1} = (12)^{(1.4-1)/1.4}$$
$$T_2 = 610.181 \text{ K}$$

as 2 – 3 constant volume process

$$\frac{P_2}{P_3} = \frac{T_2}{T_3}$$
$$T_3 = \frac{P_3}{P_2}\times T_2 = \frac{35}{12}\times 610.181$$
$$T_3 = 1779.694 \text{ K}$$
$$r = \frac{V_1}{V_2} = \left(\frac{P_2}{P_1}\right)^{1/\gamma}$$
$$r = 5.899$$

For 3-4 process

$$T_3V_3^{\gamma-1} = T_4V_4^{\gamma-1}$$
$$T_4 = T_3\times\left(\frac{V_3}{V_4}\right)^{\gamma-1}$$
$$T_4 = T_3\times\left(\frac{V_2}{V_1}\right)^{\gamma-1}$$
$$T_4 = \frac{T_3}{(5.894)^{\gamma-1}}$$
$$T_4 = 875.0522 \text{ K}$$
$$W_C = c_v(T_2 - T_1) = 222.71 \text{ kJ/kg}$$
$$W_T = c_v(T_3 - T_4) = 649.5328 \text{ kJ/kg}$$
$$W_{net} = W_T - W_C = 426.822 \text{ kJ/kg}$$
$$W_{net} = mep \times V_S$$
$$V_S = (V_1 - V_2) = V_1\left(1-\frac{V_2}{V_1}\right) = \frac{RT_1}{P_1}\left(1-\frac{1}{5.899}\right)$$
$$= \frac{0.2872\times 300}{100}\times 0.83048$$
$$V_S = 0.7155 \text{ m}^3\text{/kg}$$

So, $$\text{mep} = \frac{W_{net}}{V_S} = 596.5022 \text{ KPa} = 5.96 \text{ bar}$$

Alternate solution:

$$\eta_{otto} = \frac{W_{net}}{Q_s} = 1-\frac{1}{(r)^{\gamma-1}} = 1-\frac{1}{(5.89)^{1.4-1}} = 0.508$$
$$Q_s = c_v\,(T_3 - T_2) = 0.718 \times (1779.69 - 610.18) = 839.71 \text{ kJ/kg}$$

$$W_{net} = Q_s \times \eta_{otto} = 839.71 \times 0.508 = 426.58 \text{ kJ/kg}$$

$$= P_{imep} \times v_1\left(1 - \frac{1}{r}\right)$$

$$426.58 = P_{imep} \times \frac{RT_1}{P_1}\left(1 - \frac{1}{5.89}\right)$$

$$426.58 = P_{imep} \times \frac{0.287 \times 300}{100}\left(1 - \frac{1}{5.89}\right)$$

$$P_{imep} = 586.77 \text{ kPa} = 5.96 \text{ bar}$$

12. (c)

At full load:

$$bp + fp = 40 \text{ kW} \quad \text{...(1)}$$

at half load, $bp = 0.5 \times bp$ at full load

$$\eta_m = 0.65 = \frac{0.5 \times bp}{0.5bp + fp}$$

$$0.5bp = 0.65(0.5bp + fp)$$

$$0.5bp = 0.325bp + 0.65 \times fp$$

$$fp = \frac{0.175}{0.65} \times bp = 0.27bp$$

Put in equation (1)

$$bp + 0.27bp = 40$$

$$bp = 31.5 \text{ kW}$$

$$fp = 8.5 \text{ kW}$$

Mechanical efficiency at full load, $\eta_m = \frac{bp}{bp + fp} = \frac{31.5}{40}$

$$\eta_m = 78.8\%$$

Indicated thermal efficiency at full load

$$\eta_{ith} = \frac{\eta_{bth}}{\eta_m} = \frac{0.3}{0.788} = 0.381 = 38.1\%$$

13. (b)

Air standard efficiency for petrol engine,

$$\eta_{air} = 1 - \frac{1}{(r)^{\gamma - 1}} = 1 - \frac{1}{(8)^{1.4-1}}$$

$$\eta_{air} = 0.56472$$

$$\eta_{indicated} = \eta_{air} \times \eta_{relative}$$

$$= 0.56472 \times 0.90$$

$$\eta_{indicated} = 0.50825$$

$$\eta_{brake} = \eta_{indicated} \times \eta_{mechanical}$$

$$= 0.50825 \times 0.75$$

$$\eta_{brake} = 0.38119$$

Brake specific fuel consumption

$$BSFC = \frac{3600}{\eta_{brake} \times CV} = \frac{3600}{0.38119 \times 40 \times 10^3}$$

$$BSFC = 0.2361 \text{ kg/h-kW}$$

14. (c)

15. (c)

$$V_a = \frac{\pi}{4} d^2 L = \frac{\pi}{4} \times 25^2 \times 37.5 = 18407.8 \text{ cc}$$

$$r = 1 + \frac{V_s}{V_c} = 1 + \frac{18407.8}{1500} = 13.27$$

$$\eta = 1 - \frac{1}{r^{\gamma-1}} \frac{r_c^{\gamma} - 1}{\gamma(r_c - 1)}$$

$$r_c = \frac{V_3}{V_2}$$

$$\text{Cut-off volume} = V_3 - V_2 = 0.05V_s = 0.05 \times 12.27V_c$$

$$V_2 = V_c$$

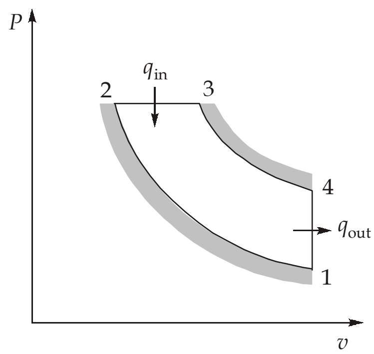
$$V_3 = 1.6135V_c$$

$$r_c = \frac{V_3}{V_2} = 1.6135$$

$$\eta = 1 - \frac{1}{13.27^{0.4}} \times \frac{1.6135^{1.4} - 1}{1.4 \times (1.6135 - 1)}$$

$$= 0.6052 = 60.52\%$$

16. (c)



The properties of air at room temperature are c_p = 1.005 kJ/kgK, c_v = 0.718 kJ/kgK, R = 0.287 kJ/kgK and γ = 1.4

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1} = (293\text{K})(20)^{0.4} = 971.1\text{K}$$

Process 2-3: constant pressure heat addition,

$$\frac{P_3V_3}{T_3} = \frac{P_2V_2}{T_2} \Rightarrow \frac{V_3}{V_2} = \frac{T_3}{T_2} = \frac{2200\,\text{K}}{971.1\,\text{K}} = 2.265 \qquad \text{(given } T_3 = 2200 \text{ K)}$$

Process 3-4: isentropic expansion,

$$T_4 = T_3\left(\frac{V_3}{V_4}\right)^{\gamma-1} = T_3\left(\frac{2.265V_2}{V_4}\right)^{\gamma-1} = T_3\left(\frac{2.265}{r}\right)^{\gamma-1}$$

$$= (2200)\left(\frac{2.265}{20}\right)^{0.4} \qquad [\because V_4 = V_1]$$

$$= 920.6 \text{ K}$$

$$q_{in} = h_3 - h_2 = c_p(T_3 - T_2) = (1.005)(2200 - 971.1) = 1235.04 \text{ kJ/kg}$$

$$q_{out} = u_4 - u_1 = c_v(T_4 - T_1) = (0.718)(920.6 - 293) = 450.6 \text{ kJ/kg}$$

$$w_{net,\,out} = q_{in} - q_{out} = 1235 - 450.6 = 784.4 \text{ kJ/kg}$$

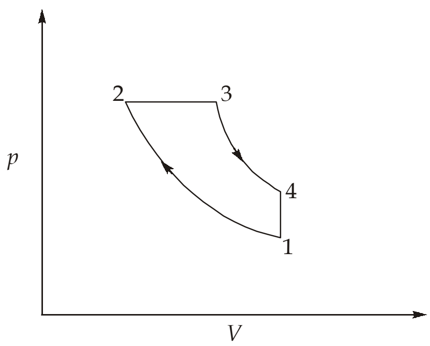
$$\eta_{th} = \frac{w_{net,out}}{q_{in}} = \frac{784.4\,\text{kJ/kg}}{1235.04\,\text{kJ/kg}} = 63.5\%$$

17. (b)

$$V_1 = 16V_2 \qquad V_3 = 2V_2$$

$$V_s = V_1 - V_2 = (r-1)V_2 = 15V_2$$

$$V_2 = \frac{V_s}{15}$$



Consider the process 1-2

$$p_2 = p_1\left(\frac{V_1}{V_2}\right)^{\gamma} = 1 \times 16^{1.4} = 48.5 \text{ bar}$$

$$p_2 = p_3 = 48.5 \text{ bar}$$

$$p_4 = p_3\left(\frac{V_3}{V_4}\right)^{1.4} = 48.5 \times \left(\frac{2}{16}\right)^{1.4} = \frac{48.5}{8^{1.4}} = 2.64 \text{ bar (Since, } V_4 = V_1)$$

$$p_m = \frac{1}{V_s}\left[p_2(V_3 - V_2) + \frac{p_3V_3 - p_4V_4}{\gamma - 1} - \frac{p_2V_2 - p_1V_1}{\gamma - 1}\right]$$

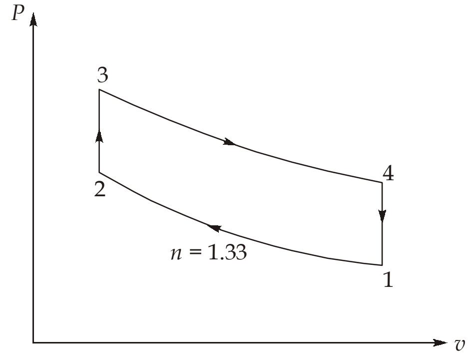
$$= \frac{V_2}{V_s}\left[p_3\left(\frac{V_3}{V_2} - 1\right) + \frac{p_3\left(\frac{V_3}{V_2}\right) - p_4\left(\frac{V_4}{V_2}\right)}{\gamma - 1} - \frac{p_2 - p_1\left(\frac{V_1}{V_2}\right)}{\gamma - 1}\right]$$

$$= \frac{1}{15} \times \left[48.5 \times (2-1) + \frac{48.5 \times 2 - 2.64 \times 16}{1.4 - 1} - \frac{48.5 - 1 \times 16}{1.4 - 1}\right]$$

$$= 6.94 \text{ bar}$$

18. **(b)**

Given: $P_1 = 1$ bar, $T_1 = 300$ K, $n = 1.33$, CV = 42000 kJ/kg, $r = 12$, A/F = 14, $C_V = (0.717 + 0.0003T)$ kJ/kg



For process 1-2:

$$\frac{P_2}{P_1} = r^n$$

$$P_2 = (1)(12)^{1.33} = 27.246 \text{ bar}$$

and,
$$\frac{T_2}{T_1} = (r)^{n-1} = (12)^{1.33-1}$$

$$T_2 = 300 \times (12)^{0.33} = 681.16 \text{ K}$$

For process 2-3: (Constant volume process)

$$Q = C_V m\Delta T;\ m = m_a + m_f$$

$$42000 = 15\int_{T_2}^{T_3}(0.717 + 0.0003T)\,dT$$

$$\Rightarrow \quad \frac{42000}{15} = 0.717(T_3 - T_2) + \frac{0.0003}{2}\left(T_3^2 - T_2^2\right)$$

$$\frac{42000}{15} = 0.717(T_3 - 681.16) + \frac{0.0003}{2}\left(T_3^2 - (681.16)^2\right)$$

$\Rightarrow 1.5 \times 10^{-4}\, T_3^2 + 0.717T_3 - 3358.38 = 0$

$\Rightarrow T_3^2 + 4780T_3 - 22389200 = 0$

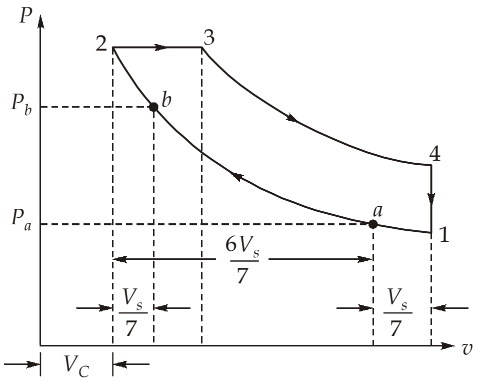
$\Rightarrow \quad T_3 = 2911.065$ K

and maximum pressure of the cycle,

$$P_3 = P_2 \times \frac{T_3}{T_2} \quad [\because \text{ Constant volume process}]$$

$$= 27.246 \times \left(\frac{2911.065}{681.16}\right) = 116.44 \text{ bar}$$

19. (a)



Process 1-2 (Isentropic compression)

$$\therefore \quad 1.8V_a^{\gamma} = 18V_b^{\gamma}$$

$$\Rightarrow \quad 1.8\left(V_C + \frac{6V_s}{7}\right)^{1.4} = 18\left(V_C + \frac{V_s}{7}\right)^{1.4}$$

$$\Rightarrow \quad \frac{V_C + \frac{6V_s}{7}}{V_C + \frac{V_s}{7}} = 5.1794$$

$$\Rightarrow \quad C + \frac{6}{7} = \left(C + \frac{1}{7}\right) \times 5.1794 \qquad \left[\because C = \frac{V_C}{V_s}\right]$$

$$C = 0.0280$$

So,
$$r = 1 + \frac{1}{C} = 1 + \frac{1}{0.0280} = 36.65$$

Now,
$$V_3 - V_2 = \frac{1}{12}(V_1 - V_2)$$

$$r_C - 1 = \frac{1}{12}(r-1)$$

$$r_C = 3.97$$

$$\eta_{\text{diesel}} = 1 - \left(\frac{1}{\gamma \cdot r^{\gamma-1}}\right)\left(\frac{r_c^{\gamma} - 1}{r_c - 1}\right)$$

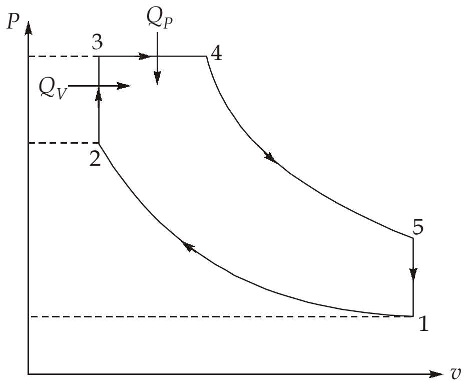
$$= 1 - \frac{1}{(36.65)^{0.4}}\left(\frac{1}{1.4}\right)\left(\frac{3.97^{1.4} - 1}{3.97 - 1}\right) = 1 - 0.3356 = 0.6643 = 66.43\%$$

20. (c)

Given: T_1 = 27°C = 300 K, P_1 = 1 bar, T_2 = 350°C = 623 K, $T_{4(max)}$ = 1800°C = 2073 K, c_p = 1.005 kJ/kgK, c_v = 0.707 kg/kgK

$$\therefore \quad \gamma = \frac{c_p}{c_v} = 1.42$$

$$Q_P = 2Q_V$$



For process 1-2:

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma}$$

$$\frac{623}{300} = \left(\frac{P_2}{1}\right)^{(1.4-1)/1.4}$$

$\Rightarrow$ $$P_2 = 12.9 \text{ bar}$$

We have, $$Q_P = 2Q_V$$

$\Rightarrow$ $$c_p(T_4 - T_3) = 2[c_v(T_3 - T_2)] = 1.005\ (2073 - T_3) = 2(T_3 - 623) \times 0.707$$

$$T_3 = 1225.45 \text{ K}$$

$$\text{Explosion ratio, } \alpha = \frac{P_3}{P_2} = \frac{T_3}{T_2}$$

$$\alpha = \frac{1225.45}{623} = 1.967 \text{ bar}$$

$$\text{Cut off ratio, } \rho = \frac{V_4}{V_3} = \frac{T_4}{T_3}$$

$\therefore$ $$\rho = \frac{2073}{1225.42} = 1.691$$

Thus, the product of explosion ratio and cut-off ratio is

$$\alpha \times \rho = 1.967 \times 1.691 \simeq 3.32$$

21. (b)

$$\text{Indicated power, } IP = P_{\text{eff imep}} \times V_s \times \frac{(\text{Number of explosion})}{\text{Time of test}} \quad \text{... (i)}$$

Now, effective indicated mean effective pressure,

$$P_{\text{eff, imep}} = P_{\text{imep}} - P_{\text{pumping mep}}$$
$$= 6.4 - 0.6 = 5.8 \text{ bar}$$

From equation (i),

$$IP = 5.8 \times 10^5 \times \frac{\pi}{4} \times \frac{0.25^2 \times (1.9 \times 0.25) \times 3300}{1000 \times 40 \times 60}$$
$$= 18.594 \text{ kW}$$

$$\text{Brake power, } BP = (m_b \times g) \times r_d \times \left(\frac{2\pi \times \text{Number of revolution}}{\text{Time of test}}\right)$$

$$= 90 \times 9.81 \times 0.8 \times \frac{2\pi \times 8080}{1000 \times 40 \times 60}$$

$$= 14.941 \text{ kW}$$

$$\text{Mechanical efficiency, } \eta_m = \frac{BP}{IP} = \frac{14.941}{18.594} = 0.8035 = 80.35\%$$

22. (c)

$$\text{Heat supplied/kg} = c_v (T_3 - T_2) + c_p (T_4 - T_3) \ \ldots \text{ (i)}$$

$$\frac{T_2}{T_1} = \left(\frac{V_2}{V_1}\right)^{\gamma-1} = (10)^{1.4-1}$$

$$T_2 = (10)^{0.4} \times 300$$

$$= 753.57 \text{ K} = 480.57°\text{C}$$

Now, from equation (i),

$$878 = 0.717\,(987 - 480.57) + 1.004(T_4 - 987)$$

$$T_4 = 1499.84°\text{C} = 1772.84 \text{ K}$$

$$\text{Cut-off ratio, } r_c = \frac{V_4}{V_3}$$

For constant pressure process (3–4)

$$\frac{V_4}{V_3} = \frac{T_4}{T_3}$$

So,

$$r_c = \frac{T_4}{T_3} = \frac{1772.84}{1260} = 1.407 \qquad [\because T_3 = 987°\text{C} = 1260 \text{ K}]$$

23. (d)

$$V_s = \frac{\pi}{4} \times 0.06^2 \times 0.1$$

$$= 2.83 \times 10^{-4} \text{ m}^3/\text{cylinder} = 283 \text{ cc/cylinder}$$

$$\text{Compression ratio, } r = \frac{V_s + V_c}{V_c} = \frac{283 + 60}{60} = 5.72$$

$$\eta_{\text{air-std}} = 1 - \frac{1}{(r)^{\gamma-1}} = 0.5021 = 50.21\%$$

$$\eta_{bth} = \eta_{\text{relative}} \times \eta_{\text{air-std}} = 0.5021 \times 0.52$$

$$= 0.2611 = 26.11\%$$

$$\text{BP} = \frac{2\pi NT}{60} = \frac{2\pi \times 3000 \times 65}{1000 \times 60} = 20.420 \text{ kW}$$

$$\eta_{bth} = \frac{BP(\text{Brake power})}{Q_s(\text{Heat supplied})} = \frac{BP}{\dot{m}_f \times CV}$$

$$\dot{m}_f = \frac{20.420 \times 3600}{0.2611 \times 43 \times 1000} = 6.547 \text{ kg/ hr}$$

24. (a)

The Stoichiometric equation can be written as

$C_8H_{18} + 12.5(O_2 + 3.76N_2) \rightarrow 8CO_2 + 9H_2O + 47N_2$

$$\therefore \quad \left(\frac{A}{F}\right)_{\text{Stochiometric}} = \frac{12.5(32 + 3.76 \times 28)}{12 \times 8 + 18 \times 1}$$

$$= 15.05$$

25. (a)

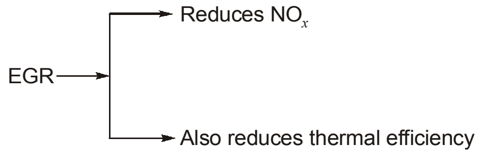
Clearance volume of a single cylinder,

$$V_c = \frac{9000}{6} = 1500\,\text{cm}^3$$

$$\text{Swept volume, } V_s = \frac{\pi}{4}D^2L = 0.785 \times (15)^2 \times 30 = 5298.75\,\text{cm}^3$$

$$r = \frac{V_s + V_c}{V_c} = \frac{5298.95 + 1500}{1500} = 4.5325$$

26. (b)



27. (a)

$$\eta_{\text{bth}} = \frac{BP}{m_f \times CV}$$

$$\Rightarrow \quad m_f = \frac{50}{0.25 \times 44000} = 4.545 \times 10^{-3} \text{ kg/sec} = 16.36 \text{ kg/hr}$$

$$= \frac{16.36}{0.74} = 22.1\ l/\text{hr}$$

$$\eta_{\text{ith}} = \frac{\eta_{bth}}{\eta_m} \qquad \left\{\eta_m = \frac{b.P.}{i.P.} = \frac{\eta_{bth}}{\eta_{ith}}\right\}$$

$$= \frac{0.25}{0.75} = 33.3\ \%$$

28. (a)

In four stroke cycle there is one effective working stroke in every two revolution of the engine crankshaft i.e. $n = \frac{N}{2}$

$$\text{Indicated power} = \frac{P_m LAnk}{1000} kW$$

$$= \frac{4.5 \times 10^5 \times 0.25 \times \frac{\pi}{4} \times 0.2^2 \times \frac{360}{2 \times 60} \times 1}{1000} = 10.6 \text{ kW}$$

$$\text{Indicated thermal efficiency} = \frac{i.p.}{m_f \times CV} = \frac{10.6}{\frac{5}{3600} \times 44000} = 17.35\ \%$$

29. (d)

$$\eta_{Otto} = 1-\left(\frac{v_c}{v_c+v_s}\right)^{\gamma-1}$$

$$v_C = 196.3 \text{ cm}^3$$

$$v_s = \frac{\pi}{4}\times D^2L = \frac{\pi}{4}\times 10^2\times 15 = 1178.097 \text{ cm}^3$$

$$\gamma = 1.4$$

$$\therefore \quad \eta_{Otto} = 1-\left(\frac{196.3}{196.3+1178.097}\right)^{1.4-1} = 0.5408$$

$$\therefore \quad \eta_{Otto} = 54.08\%$$

$$\therefore \quad \text{Work output} = \eta_{Otto} \times (\text{Heat supplied}) = 0.5408 \times 1800 \text{ kJ} = 973.58 \text{ kJ}$$

30. (c)

Net brake power: $bp_{1,2} = 10$ kW

Brake power of cylinder-1,

$$bp_1 = 4.75 \text{ kW}$$

Brake power of cylinder-2,

$$bp_2 = 4 \text{ kW}$$

Net indicated power,

$$ip_{1,2} = bp_{1,2} + fp$$

$$= 10 + fp \qquad ...(1)$$

Indicated power of cylinder-1, when spark cut-off of cylinder-2,

$$ip_1 = bp_1 + fp$$

$$ip_1 = 4.75 + fp \qquad ...(2)$$

Indicated power of cylinder-2,

$$ip_2 = ip_{1,2} - ip_1$$

$$= 10 - 4.75 = 5.25 \text{ kW}$$

Indicated power of cylinder-2, when spark cut-off of cylinder-1,

$$ip_2 = bp_2 + fp$$

$$= 4 + fp \qquad ....(3)$$

Indicated power of cylinder-1,

$$ip_1 = ip_{1,2} - ip_2$$

$$= 10 - 4 = 6 \text{ kW}$$

Net indicated power: $ip_{1,2} = ip_1 + ip_2$

$$= 6 + 5.25 = 11.25 \text{ kW}$$

Mechanical efficiency: $\eta_m = \dfrac{\text{Net brake power}}{\text{Net indicated power}}$

$$= \frac{bp_{1,2}}{ip_{1,2}} = \frac{10}{11.25} = 0.8888 = \mathbf{88.88\%}$$

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