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COURSE : EEE 552 (ASSIGNMENT 2)

⇒ SOLUTION.

1.) Parameters given:

$D = 1500m$

Schedule speed = 36 km/h

$= \frac{36 \times 5}{18}$ m/s

= 10 m/s

$\beta = 3 km/h/s = 3 \times 5/18 = 0.833 m/s^2$

Schedule time of run = $\frac{\text{Distance (D)}}{\text{Schedule speed}} = \frac{1500}{10} = 150s$

Actual time of run = Schedule time of run − 25s

= 150 − 25 = 125s

$$K = \frac{D}{V_m^2}\left(\frac{V_m}{V_a} - 1\right)$$

where $V_a = \frac{1500}{125} = 12 m/s$

$V_m = 1.25 \times 12 = 15 m/s$

$$K = \frac{1500}{15^2}(1.25 - 1) = \frac{5}{3}$$

$$K = \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$$

$$\frac{5}{3} = \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{0.833}\right)$$

$\alpha = 0.47 m/s^2$

Acceleration, $\alpha = 0.47 \times 18/5 = 1.7 km/h/s$

2.) Parameters given:

$V_a = 36\,km/h = 36 \times 5/18 = 10\,m/s$

$V_m = \frac{t - \sqrt{t^2 - 4KD}}{2K}$

$\alpha = 1.8\,km/h/s = 1.8 \times 5/18 = 0.5\,m/s^2$

$\beta = 3.6\,km/h/s = 3.6 \times 5/18 = 1\,m/s^2$

$t = \frac{D}{V_a} = \frac{2000}{10} = 200\,s$

$K = \frac{(\alpha + \beta)}{2\alpha\beta}$

$K = \frac{(0.5 + 1)}{2(0.5 \times 1)}$

$K = 1.5$

$\therefore$ Maximum speed, $V_m = \frac{200 - \sqrt{200^2 - (4 \times 1.5 \times 2000)}}{2 \times 1.5}$

$V_m = 11\,m/s$

$V_m = 11 \times 18/5$

$= 39.6\,km/h$

3.) Parameters given

Surface area $= 6\,m^2$

Total surface area $= 6L^2$ (assuming L is the side of the tank)

$\therefore L = \sqrt{\frac{6}{6}} = 1\,m$

Volume of the tank $= L^3 = 1\,m^3$

Volume of tank to be heated daily $= \left(\frac{90}{100} \times 1\right) 6$

$= 5.4\,m^3$

Mass of water to be heated daily $= 5.4 \times 1000$ $(1\,m^3 = 1000\,kg)$

$= 5400\,kg$

Heat required to raise the temperature of water = MCθ

$= 5400 \times 4200 \times (65-20)$

$= 1020\ MJ$

$1\ kWh = 3.6\ MJ$

$\frac{1020 \times 1}{3.6} = 1020\ MJ$

$= 283.3\ kWh.$

Daily loss from the surface of the tank $= 6.3 \times 6 \times (65-20)$

$= 24/1000$

$= 40.8\ kWh$

Energy supplied per day $= 283.3 + 40.8 = 324.1\ kWh$

Loading in kW $= 324.1 / 24 = 3.5\ kW$

Efficiency of the tank $= \frac{283.3 \times 100}{324.1} = 87.4\%$

4.) Parameters given

Secondary voltage, $V_2 = 10V$

Power, $P = 400kW$

Secondary current, $I_2 = \frac{P}{V_2} \cos\phi$

$= \frac{400 \times 10^3}{10 \times 0.6} = 6.667 \times 10^4\ A$

Impedance Z_2 of secondary circuit when heater is full

$Z_2 = V_2 / I_2 = \frac{10}{6.667 \times 10^4} = 15 \times 10^{-4}\ \Omega$

Secondary resistance, R_2 when heater is full

$R_2 = Z_2 \cos\phi$

$= 1.5 \times 10^{-4} \times 0.6 = 0.9 \times 10^{-4}\ \Omega$

Reactance of secondary circuit, $x_2 = Z_2 \sin\phi$
$X_2 = 1.5\times10^{-4} \times 0.8 = 1.2\times10^{-4}\Omega$

Let the height of the charge be x times, height of full hearth
$h = xH$
Recall: resistance varies inversely as the height of the charge.
$R_2 = R_2/x = 0.9\times10^{-4}\ \Omega$

∴ Power drawn and heat produced will be maximum where $R_2 = X_2$

$$\therefore \frac{0.9\times10^{-4}}{x} = 1.2\times10^{-4}$$

$$x = 3/4$$

∴ Maximum heat would be produced when its height is 3/4 th the height of the hearth.

~~5) a) Without reflector. $E = \frac{300}{20^2} = 0.75$ lux~~

~~b) $\theta =$~~

5.) Parameters given.
CP = 300
d = 20m
h = 20m

a) Without reflector
Illumination, $E = \frac{300}{20^2} = 0.75$ lux

Scanned with CamScanner

b.) Without reflector at the edge of the surface

$\theta = \tan^{-1}\left(\frac{10}{20}\right) = \tan^{-1}(0.5) = 26.6°$

$\cos\theta = 0.89$, $r^2 = 10^2 + 20^2 = 500$

$\therefore E = \frac{300}{0.89 \times 500}$

$= 0.584$ lux.

With reflector, the illumination is the same at all points

$\therefore$ luminous output of lamp $= 300 \times 4\pi$ lumen.

flux directed by reflector $= 0.5 \times 1200\pi$

$= 600\pi$ lm

$\therefore$ Illumination, $E = \frac{600\pi}{100\pi}$

$= 6$ lux.