Answer Key

Physics and Engineering Mechanics 2

exponential LEAP ONLINE REVIEW

$$\dot{V}_F = \frac{2.4\,L}{12\,min}$$

$$SG_F = 0.80$$

$$Q_F = 42000\,\frac{kJ}{kg}$$

$$e = 33\%$$

Find: Brake horse power of the engine

$$e = \frac{BP}{\dot{m}_F Q_F}$$

$$\dot{m}_F = \rho \dot{V} \;;\; SG = \frac{\rho_F}{\rho_W}$$

$$= (0.80)\left(1\,\frac{kg}{L}\right)\left(\frac{2.4}{12}\,\frac{L}{min}\right)$$

$$\dot{m}_F = 0.16\,\frac{kg}{min}$$

Hence;

$$BP = (0.33)\left(0.16\,\frac{\cancel{kg}}{\cancel{min}}\right)\left(\frac{1\,\cancel{min}}{60\,sec}\right)\left(42000\,\frac{kJ}{\cancel{kg}}\right)$$

$$BP = (36.96\,kW)\left(\frac{1\,hp}{0.746\,kW}\right)$$

$$\boxed{BP = 49.5442\,hp}$$

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Given: $KE_1 = 28\ J$

$KE_2 = 128\ J$

$m = 3.2\ kg$

from;

$$\Delta PE = \Delta KE$$

$$m\left(\frac{g_o}{g_c}\right)\Delta z = (KE_2 - KE_1)$$

$$(3.2\ kg)\left(\frac{9.81\ m/s^2}{1\ \frac{kg-m}{N-s^2}}\right)\Delta z = (128 - 28)\ J$$

$$\boxed{\Delta z = 3.1855\ m}$$

3

$$\dot{V}_F = \left(\frac{6\ \text{gal}}{\text{hr}}\right)\left(\frac{3.78\ \text{L}}{1\ \text{gal}}\right)\left(\frac{1\ \text{hr}}{3600\ \text{s}}\right) = 6.3\times10^{-3}\ \frac{\text{L}}{\text{sec}}$$

$$SG_F = 0.85$$

$$Q_F = \left(20300\ \frac{\text{Btu}}{\text{lb}}\right)\left(\frac{1.055\ \text{KJ}}{1\ \text{Btu}}\right)\left(\frac{2.2\ \text{lb}}{1\ \text{Kg}}\right) = 47116.3\ \frac{\text{KJ}}{\text{Kg}}$$

$$e = 35\%$$

Find Power output of the engine

$$e = \frac{BP}{\dot{m}_F Q_F}$$

$$\dot{m}_F = \rho \dot{V}\ ;\ SG = \frac{\rho_F}{\rho_w}$$

$$= (0.85)\left(1\ \frac{\text{kg}}{\text{L}}\right)\left(6.3\times10^{-3}\ \frac{\text{L}}{\text{sec}}\right)$$

$$\dot{m}_F = 5.355\times10^{-3}\ \text{kg/sec}$$

Hence;

$$BP = (0.35)\left(5.355\times10^{-3}\ \frac{\text{kg}}{\text{sec}}\right)\left(47116.3\ \text{KJ/kg}\right)$$

$$\boxed{BP = 88.3077\ \text{kW}}$$

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Given: $P = 15\ kW$

$e = 82\%$

$W = 1550\ lb_f$

$$e = \frac{P_{out}}{P_{IN}} * 100\%$$

$$0.82 = \frac{P_{out}}{15\ kW}$$

$$P_{out} = 12.3\ kW$$

and;

$$W = 1550\ lb_f \left(\frac{4.448\ N}{1\ lb_f}\right) = 6894.4\ N$$

Hence;

$$P = F \cdot v$$

$$12300\ \frac{J}{s} = 6894.4\ N\ v$$

$$\boxed{v = 1.7841\ m/s}$$

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Given: $m = 5\ lbm$

$r = 3.8\ in$

$N = 1400\ rpm$

Find: KE

$$KE = \frac{1}{2}\frac{m}{g_c}v^2$$

$$v = 2\pi r N$$

$$= 2\pi(3.8\ in)\left(\frac{1\ ft}{12\ in}\right)\left(\frac{1400\ rpm}{60}\right)$$

$$v = 46.4258\ ft/sec$$

substi

$$KE = \frac{1}{2}\left(\frac{5\ lbm}{32.2\ \frac{ft-lb}{lbf-sec}}\right)(46.4258\ ft/sec)^2$$

$$\boxed{KE = 167.3409\ ft\text{-}lb}$$

6

Given: $v = \left(70 \frac{\text{miles}}{\text{hr}}\right)\left(\frac{5280 \text{ ft}}{1 \text{ mile}}\right)\left(\frac{1 \text{ hr}}{3600 \text{ sec}}\right) = 102.6667 \text{ ft/sec}$

$m = 1200 \text{ lb}$

$$KE = \frac{1}{2}\frac{m}{g_c}v^2 = \frac{1}{2}\left(\frac{1200 \text{ lb}}{32.2 \frac{\text{ft-lb}}{\text{lb}_f\text{-sec}^2}}\right)\left(102.6667 \text{ ft/sec}\right)^2$$

$$\boxed{KE = 196405.9246 \text{ lb-ft}}$$

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$m_a = 12 g$ $\quad m_B = 12 g$

$v_A = 18 m/s$ $\quad v_B = 95 m/s$

$$m_a v_A + m_B v_B = m_a' v_A' + m_B' v_B'$$

note: $v_A' = v_B' = v'$

$$(12 g)(18 m/s) + (12 g)(95 m/s) = v'(12 + 12) g$$

$$\boxed{v' = 56.5 m/s}$$

Given: $m = 1100 \text{ slugs}$

$t = 15 \text{ sec}$

$v_f = 28 \text{ ft/sec}$

Required: Resultant force;

$$m = (1100 \text{ slugs})\left(\frac{32.2 \text{ lb}_m}{1 \text{ slug}}\right)\left(\frac{32.2 \text{ ft/sec}^2}{32.2 \frac{\text{lb-ft}}{\text{lb-sec}^2}}\right) = 35420 \text{ lb}_f$$

$$v_f = \cancel{v_i}^{\,0} + at$$

$$28 \text{ ft/sec} = a(15 \text{ sec})$$

$$a = 1.8667 \text{ ft/sec}^2$$

Hence; from 2nd Law of motion

$$F_R = m\left(\frac{a_o}{a_c}\right) = 35420 \text{ lb}_m \left(\frac{1.8667 \text{ ft/sec}^2}{32.2 \frac{\text{lb-ft}}{\text{lb}_f\text{-sec}^2}}\right)$$

$$\boxed{F_R = 2053.37 \text{ lb}_f}$$

let v = speed of coupled cars

By conservation of momentum

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$(50\ \text{ton})\left(1.5\ \frac{\text{mile}}{\text{hr}}\right) + (80\ \text{ton})(0) = 50v + 80v$$

$$\boxed{v = 0.5770\ \text{mi/hr}}$$

$$h_L = f\frac{Lv^2}{2g_oD}$$

$$Q = Av$$

$$\left(4100\,\frac{gal}{min}\right)\left(\frac{1\,min}{60\,sec}\right)\left(\frac{1\,ft^3}{7.481\,gal}\right) = \frac{\pi}{4}(1.4\,ft)^2 v$$

$$v = 5.9337\ ft/sec$$

Subst;

$$h_L = 0.0157\,\frac{(260\,ft)(5.9337\,ft/sec)^2}{2(32.2\,ft/sec^2)(1.4\,ft)} = 1.5941\,ft$$

Hence;

$$P = \gamma h_L = \left(62.4\,\frac{lb}{ft^3}\right)(1.5941\,ft)$$

$$\boxed{P = 99.4706\,\frac{lb}{ft^2}}$$

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$$Q = m C_p \Delta T$$

$$= 3\frac{kg}{s}\left(4.187\ kJ/kg\text{-}K\right)(95 - 34)^{\circ}C$$

$$Q = 766.221\ kW$$

and :

$$0.75P = Q$$

$$0.75P = 766.221\ kW$$

$$P = 1021.628\ kW$$

Hence ;

$$P = VI$$

$$1021.628\times10^3\ W = (2000\ V)I$$

$$\boxed{I = 510.814\ amp}$$

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$$P = VI = I^2 R$$

$$1200\ W = I^2 (12\ ohms)$$

$$\boxed{I = 10\ amp}$$

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$$\text{Power Factor} = \frac{kW}{kVA}$$

$$= \frac{(220V)(11\,A)}{2600\,VA}$$

$$\text{Power Factor} = 0.9308$$

$$\boxed{\text{Power Factor} = 93.08\%}$$

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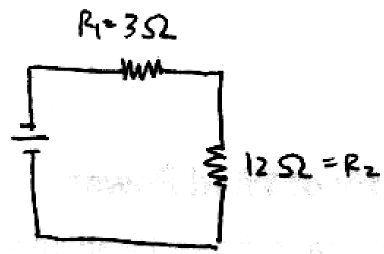

$$R_T = R_1 + R_2 = 15\,\Omega$$

$$I_T = I_1 = I_2 = \frac{V_T}{R_T} = \frac{450\,V}{15\,\Omega} = 30 \text{ amps}$$

Hence;

$$V_2 = I_2 R_2$$

$$= (30 \text{ amps})(3\,\Omega)$$

$$\boxed{V_2 = 90\,V}$$

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$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$$\frac{200V}{V_2} = \frac{280 \text{ turns}}{50 \text{ turns}}$$

$$\boxed{V_2 = 35.7143 \text{ V}}$$

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}$$

$$7.6\,\mu F = \frac{1}{\frac{1}{9.8\,\mu F} + \frac{1}{C_2}}$$

$$\boxed{C_2 = 33.8545\,\mu F}$$

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$$P = VI$$

$$= (230\,V)(18\,A)$$

$$P = (4140\,W)\left(\frac{1\,hp}{746\,W}\right)$$

$$\boxed{P = 5.5496\ hp}$$

exponential LEAP ONLINE REVIEW

$$Q = It$$

$$630 \text{ coulombs} = I(18\text{sec})$$

$$\boxed{I = 35 \text{ amps}}$$

$$\tan\theta = \frac{v^2}{gr}$$

$$\tan 9^\circ = \frac{(20\ m/s)^2}{(9.81\ m/s^2)r}$$

$$\boxed{r = 257.4414\ m}$$

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$$\tan\theta = \frac{v^2}{gr} = \frac{\left[\left(60\ \text{miles}/\text{hr}\right)\left(\frac{1\ \text{hr}}{3600\ \text{sec}}\right)\left(\frac{5280\ \text{ft}}{1\ \text{mile}}\right)\right]^2}{\left(32.2\ \text{ft}/\text{sec}^2\right)\left(1800\ \text{ft}\right)}$$

$$\tan\theta = 0.1336$$

$$\boxed{\theta = 7.6102^\circ}$$

$$\rho_o V_o = \rho_F V_d$$

$$(0.75)\left(62.4\,\frac{lb}{ft^3}\right)\left[(1.5\,in^2)\left(\frac{1\,ft^2}{144\,in^2}\right)(28\,in)\left(\frac{1\,ft}{12\,in}\right)\right] = \left(62.4\,\frac{lb}{ft^3}\right)\left[(L)(1.5\,in^2)\left(\frac{1\,ft^2}{144\,in^2}\right)\right]$$

$$L = (1.75\,ft)\left(\frac{12\,in}{1\,ft}\right)$$

$$\boxed{L = 21\,ft}$$

$$\frac{P_1 - P_2}{\gamma} = \frac{v_2^2 - v_1^2}{2g_o}$$

$$m = \rho_1 A_1 v_1$$

$$100\,\frac{lb}{sec} = 62.4\,\frac{lb}{ft^3}\left(\frac{\pi}{4}\right)(5in)^2\left(\frac{1ft^2}{144in^2}\right)v_1$$

$$v_1 = 11.7529\ ft/sec^2$$

$$m = \rho_2 A_2 v_2$$

$$100\,\frac{lb}{sec} = 62.4\,\frac{lb}{ft^3}\left(\frac{\pi}{4}\right)(1.0)^2\left(\frac{1ft^2}{144in^2}\right)v_2$$

$$v_2 = 293.8245\ ft/sec$$

Hence;

$$\Delta P = \frac{(293.8245^2 - 11.7529^2)\ ft^2/sec^2}{2(32.2\ ft/sec^2)}\left(62.4\ lb/ft^3\right)$$

$$\Delta P = \left(83517.8519\ lb/ft^2\right)\left(\frac{1ft^2}{144\ in^2}\right)$$

$$\boxed{\Delta P = 579.9851\ psi}$$

exponential LEAP
ONLINE REVIEW

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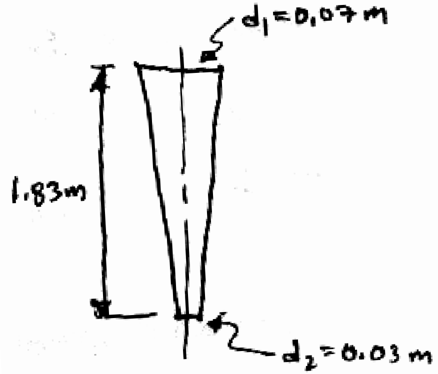


$$Q = A_1 v_1$$

$$0.03\ m^3/s = \frac{\pi}{4}(0.07m)^2 v_1$$

$$v_1 = 7.7953\ m/s$$

$$Q = A_2 v_2$$

$$0.03\ m^3/s = \frac{\pi}{4}(0.03m)^2 v_2$$

$$v_2 = 42.4413\ m/s$$

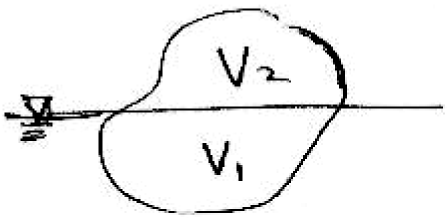
$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g_0} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g_0} + \cancel{z_2}^{\,0}$$

$$P_2 - P_1 = \left[\frac{v_2^2 - v_1^2}{2g_0} - z_1\right]\gamma$$

subst;

$$\Delta P = \left[\frac{(42.4413^2 - 7.7953^2)\,m^2/s^2}{2(9.81\ m/s^2)} - 1.83\ m\right](9.81\ kN/m^3)$$

$$\boxed{\Delta P = 852.2963\ kPa}$$



$$BF = W$$

$$(13.6)\left(9.81\,\frac{kN}{m^3}\right)V_1 = (7.8)\left(9.81\,\frac{kN}{m^3}\right)V_T$$

$$V_1 = 0.5735\,V_T$$

but: $V_T = V_1 + V_2$

$$V_T = 0.5735\,V_T + V_2$$

$$V_2 = 0.4265\,V_T$$

Hence;

$$\boxed{\frac{V_2}{V_T} = 0.4265}$$

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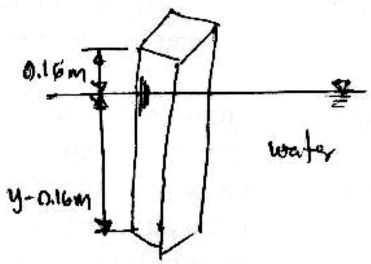

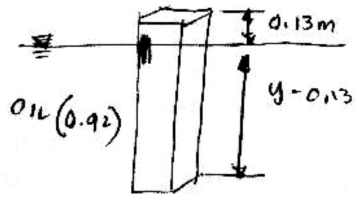

Value of "y"

$W = (9.81\ kN/m^3)(0.5m)(0.5m)(y-0.16m)$

$W_w = 2.4525\ (y-0.16m)$

$W = (9.81\ kN/m^3)(0.92)(0.5m)(0.5m)(y-0.13m)$

$W_o = 2.2563\ (y-0.13m)$

$W_w = W_{oil}$

$2.4525(y-0.16m) = 2.2563\ (y-0.13m)$

$1.08696y - 0.17391m = y - 0.13\ m$

$\boxed{y = 0.5049\ m}$