F.Y.B.Tech: In-Sem T2 Exam. (Paper-II)

Course: Engineering Mechanics: Model Ans & Marking scheme $\boxed{\text{2 pages}}$

Q.1 (a) We have $y_A + y_B = 75\ m$ ---- ①

Apply $y = ut \pm \frac{1}{2}gt^2$. Hence $y_A = \frac{1}{2}gt^2$ ---- ①

$y_B = 25t - \frac{1}{2}gt^2$ ---- ① $\boxed{6}$

$\therefore 25t = 75$ or $t = 3\ s$ ---- ②

$y_A = \frac{1}{2}(9.81)(3)^2 = 44.15\ m$ from top OR
$y_B = 25(3) - 4.905(3)^2 = 30.85\ m$ above G.L. $\}$ ①

(b) $x = t^3 - 8t^2 + 16t - 5$

$\therefore V = 3t^2 - 16t + 16$
and $a = 6t - 16$ $\}$ Hence $a = 0$ at $t = 2.67\ s$ ① + ① mark

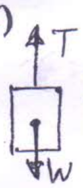
$x_{2.67} = -0.28\ m$ ---- position ① mark $\boxed{6}$

Displacement $= |x_{2.67} - x_0| = 4.72\ m$ ---- ① mark

For distance, check reversal of motion. $V = 0 = 3t^2 - 16t + 16$

$\therefore t = 4\ s$ or $t = 1.33\ s$ ---- ①

$\therefore D = |x_{2.67} - x_{1.33}| + |x_{1.33} - x_0| = 14.24\ m$ ---- ①

(c) 

Motion FBD ①

$v^2 = u^2 + 2ay$ gives $a = 1\ m/s^2 \uparrow$ ---- ① $\boxed{4}$

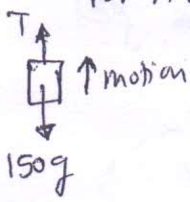
$\Sigma F_y = m \cdot a_y$ gives $T - W = m \cdot a$

$\therefore T = 5000 + \left(\frac{5000}{9.81}\right)(1)$

$\therefore T = 5509.7\ N$ or $5.51\ kN$ ---- ①

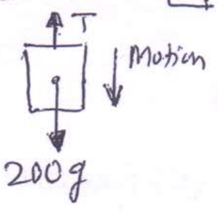
Q.2 (a) F.B.D. of each block 1+1 marks. $\boxed{6}$

For A: $T - 150g = 150\,a$ ①   For B: $200g - T = 200\,a$ ①



$\therefore T = 1681.8\ N$ ---- ①

$a_A = 1.4\ m/s^2 \uparrow$. $a_B = 1.4\ m/s^2 \downarrow$ ---- ①



(b) $\bar{V}_A = +40\cos 45\, i - 40 \sin 45\, j = 28.28 i - 28.28 j$ ---- ①

$\bar{V}_B = -50\cos 60^\circ i - 50 \sin 60\, j = -25 i - 43.3 j$ ---- ①

$\therefore \bar{V}_{B/A} = -53.28 i - 15.02 j$ ---- ①

$V_{B/A} = 55.36\ km/h$ @ 15.74° ---- ① $\boxed{6}$

$d = 27.13\ km$ ---- ΔABC ---- ①

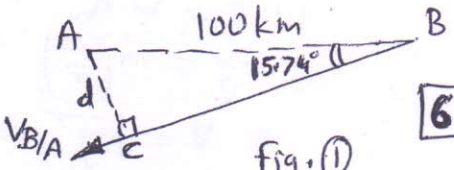


Fig. ①

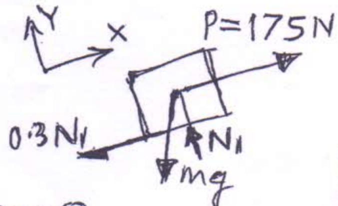
* For scalar or other correct approach, give proportionate marks *

(c) $\Sigma F = m \cdot a$ ----

$N_1 = mg\cos\theta$ ---- ① $\boxed{4}$

$P - mg\sin\theta - \mu N_1 = m \cdot a$ ---- ①

$a = 1.62\ m/s^2$ ---- ①



FBD ①

m/s , $V = 54\ km/h = 15\ m/s$ ---- ①

$V = u + at$ gives $a_t = 1\ m/s^2$ in 5 seconds ----- ①

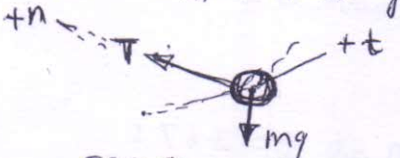
$a_n = \frac{V^2}{\rho} = \frac{10^2}{90}$ or $a_n = 1.11\ m/s^2$ ---- ①

$\therefore a = 1.49\ m/s^2$ @ $48°$ with 't' direction ① $\boxed{6}$

At $t = 3\ s$, $V = 13\ m/s$; $a_n = 1.88\ m/s^2$ ---- ①

$\therefore a = 2.13\ m/s^2$ @ $62°$ with 't' direction --- ①

(b) $\Sigma F_n = m \cdot a_n$ gives $T = m \cdot a_n$ ---- ①



FBD ①

$\therefore 58.86 = (2)(1)\omega^2$ ---- ①

$\because a_n = \rho\omega^2$ ------ ①

$\therefore \omega = 5.42\ rad/s$ ---- ① $\boxed{4}$

(c) $\bar{v} = 3t^2 i + 4t j$ gives $\bar{a} = 6t i + 4j$ ---- ①

$\therefore$ At $t = 1$, $V_x = 3$, $V_y = 4$ $\rightarrow$ $V = 5\ m/s$ --- ① $\boxed{4}$

At $t = 1$, $a_x = 6$, $a_y = 4$ $\longrightarrow a = 7.2\ m/s$ --- ②

Q.4(a) $\theta = \pi t \rightarrow \dot{\theta} = \pi$, $\ddot{\theta} = 0$ ----- ①

$r = 2\sin(3\pi t) \rightarrow \dot{r} = 6\pi\cos(3\pi t)$, $\ddot{r} = -18\pi^2\sin(3\pi t)$ --- ①

$\therefore V_r = \dot{r} = 6\pi\cos(3\pi t)$ ---------- ①

$V_\theta = r\dot{\theta} = 2\pi\sin(3\pi t)$ ------- ① $\boxed{6}$

$a_r = \ddot{r} - r\dot{\theta}^2 = -20\pi^2\sin(3\pi t)$ ------- ①

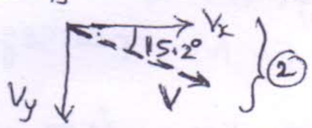
$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = 12\pi^2\cos(3\pi t)$ ------ ①

(b) $V_x = 20\cos 30° = 17.32\ m/s$ ----- ①

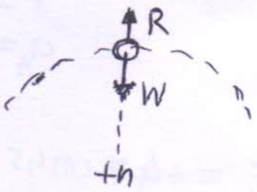
Applying $V = u - gt$ we get $V_y = (20\sin 30°) - 9.81(1.5)$

or $V_y = -4.72\ m/s$ ------ ① $\boxed{4}$

$\therefore V = \sqrt{V_x^2 + V_y^2} = 17.95\ m/s^2$
@ angle $15.2°$



(c) Reaction R at highest point will be nearly zero when contact is 'just' maintained. ——— ①



FBD ①

$\Sigma F_n = m \cdot a_n$ gives

$W - R = m \cdot a_n$

$\therefore mg = m\left(\frac{V^2}{\rho}\right)$ —— ① $\boxed{4}$

or $V = \sqrt{\rho g} = 8.86\ m/s$ ---- ①
