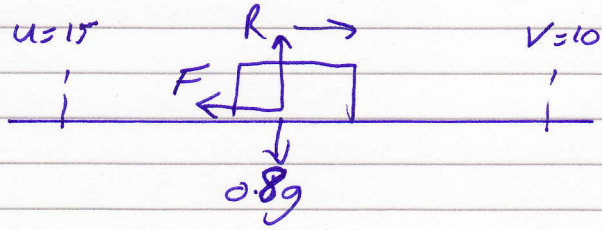
M2 - JAN 2007

Q1.



(a) wd v's friction = loss in KE = $\frac{1}{2} \times 0.8 (15^2 - 10^2) = 50$ joules

(b) wd = Force × dist

$50 = F \times 20$

$F = 2.5$ N

Now $F = \mu R$ and $R = 0.8g$

$\therefore \mu = \frac{F}{R} = \frac{2.5}{0.8g} = 0.32$

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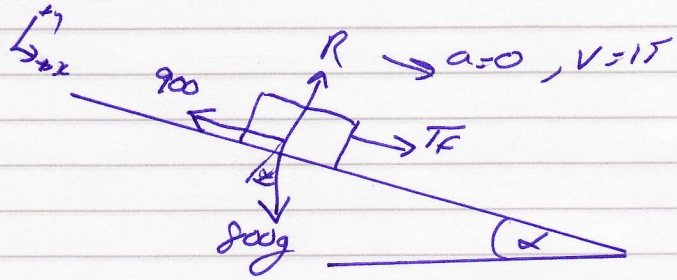
Q2



(a) N2L: $T_F - 900 + 800g\sin\alpha = 0$

$$T_F = 900 - 800g \times \frac{1}{24} = 573\tfrac{1}{3}\ N$$

Now Power $= T_F \times V = 573\tfrac{1}{3} \times 15 = 8600 = 8.6\,kW$

(b) Car now decelerates and $T_F = 0$

$\therefore$ N2L $\quad -900 + 800g\sin\alpha = 800a$

$$a = -0.72\ ms^{-2}$$

Now $u = 15$, $v = 0$, $a = -0.72$, $t = T$

Using $v = u + at$

$$0 = 15 - 0.72T$$

$$T = 20.9\ sec$$

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Q3(a) Taking A as origin

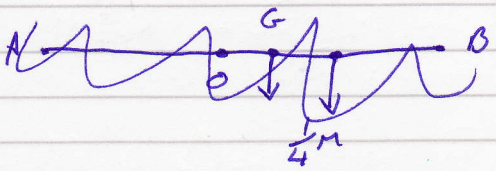
$$(\pi \times 24^2 - \pi \times 8^2)M\bar{x} = \pi \times 24^2 m(24) - \pi \times 8^2 m(16)$$

$$512\bar{x} = 13824 - 1024$$

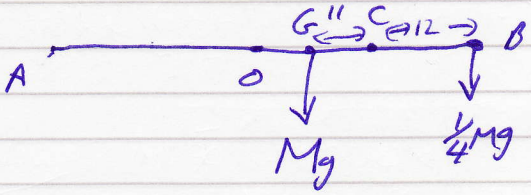
$$\bar{x} = 25 \text{ cm}$$

$\therefore$ AG = 25 cm

(b)



(b)



Let mass of T = M kg

Midpoint of AB = C

Take moments about C: $11Mg = 12 \times \frac{1}{4}mg$

$$M = \frac{3m}{11}$$

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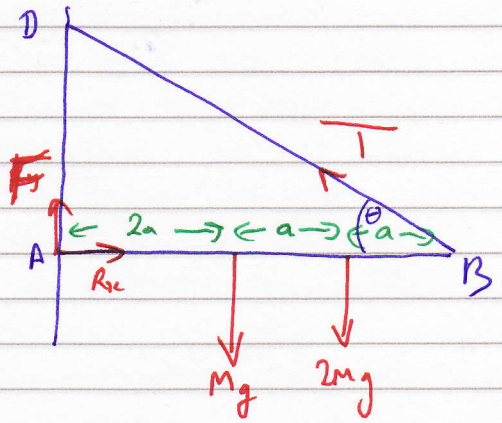
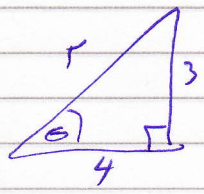
Q5





$\tan\theta = \frac{3}{4}$

$\sin\theta = \frac{3}{5}$

$\cos\theta = \frac{4}{5}$

(a) ΣG_A: $T\sin\theta \times 4a - 2mg \times 3a - mg \times 2a = 0$

$T \times \frac{3}{5} \times 4a - 6mga - 2mga = 0$

$\frac{12}{5}T = 8mg$

$T = \frac{40mg}{12} = \frac{10}{3}Mg\ N$

(b) Σf_x: $R_x - T\cos\theta = 0$

$R_x = \frac{10}{3}Mg \times \frac{4}{5}$

$\therefore R_x = \frac{8}{3}Mg$ As required

(c) Σf_y: $F + T\sin\theta - mg - 2mg = 0$

$F = 3mg - \frac{10}{3}Mg \times \frac{3}{5}$

$F = mg$

Now $F = \mu R_x$

$\mu = \frac{F}{R_x} = \frac{mg}{\frac{8}{3}mg} = \frac{3}{8}$