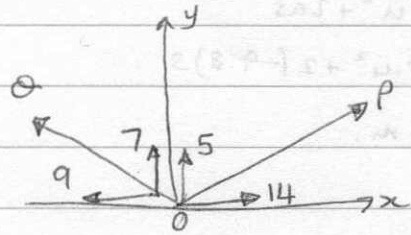
May 2007.

1. 


(i) resultant $R_x = 14 - 9 = 5$

$R_y = 5 + 7 = 12$

(ii) $R = \sqrt{R_x^2 + R_y^2} = \sqrt{25 + 144} = \sqrt{169} = 13$ N.

angle $\tan x = \frac{12}{5}$ $x = 67.38°$

2. (i) greatest distance from A is positive area beneath graph which is to a value of t halfway between 250 and 290 s = 270 s.

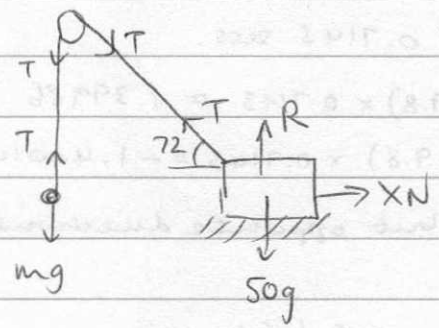
(ii) when t = 290 displacement from A has started to move back to A.

greatest displacement $= \frac{1}{2} \times 12 \times (210 + 270) = 2880$ m

returned amount $= \frac{1}{2} \times 20 \times 12 = 120$

∴ total displacement when t = 290 $= 2880 - 120 = 2760$ m.

(iii) total distance travelled $= 2880 + 120 = 3000$ m.

3. 


(i) $T = mg$ (mass)

$T \sin 72 + R = 50g$ (block)

limiting equilibrium. $F = \mu R$ (not rough) X

(ii) If block lifted off then $R = 0$

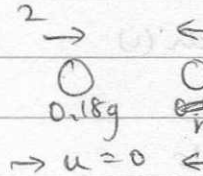
$R = 50g - T \sin 72 = 0$

$\therefore T = \frac{50g}{\sin 72} = 515.216$ N.

If $T = mg$ and $T = 515.216$

then $m = \frac{515.216}{g} = 52.57$ kg

(iii) For block $T \cos 72 = X = 159.21$ N.

4. 


(i) $2 \times 0.18 + m(-3) = 0$

$\therefore m = \frac{0.36}{3} = 0.12$ kg

(ii) a) $\leftarrow 1.5$ $\rightarrow 1.5$ m/s $\quad 2 \times 0.18 + m(-3) = 0.18(-1.5) + m(1.5)$

$\therefore 4.5m = 0.63 \quad \therefore m = 0.14$ kg

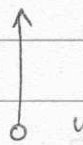
b) $\overrightarrow{\text{OO}}$ 1.5 $\quad 2 \times 0.18 + m(-3) = 1.5(0.18 + m)$

$4.5m = 0.09 \quad m = 0.02$ kg

$\overleftarrow{\text{OO}}$ 1.5 $\quad 2 \times 0.18 + m(-3) = -1.5(0.18 + m)$

$1.5m = 0.63 \quad m = 0.42$ kg

5. (i)



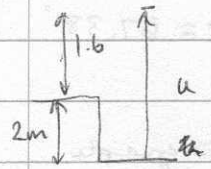

$s = \left(\frac{u+v}{2}\right)t$ or $v = u+at$ or $s = ut + \frac{1}{2}at^2$

or $\therefore v^2 = u^2 + 2as$

$0^2 = 8.4^2 + 2(-9.8)s$

$s = 3.6\,m.$

(ii) $v^2 = u^2 + 2as$




$0 = u^2 + 2(-9.8) \times 1.6$

$u = 5.6$ m/s

(iii) For P $v_p^2 = u^2 + 2as_p = 8.4^2 + 2(-9.8)s$

For Q $v_q^2 = u^2 + 2as_q = 5.6^2 + 2(-9.8)(s-2)$ $\quad s > 2$

For P $s = ut + \frac{1}{2}at^2 \quad s = 8.4t - 4.9t^2$ ①

For Q $(s-2) = 5.6t - 4.9t^2$ ②

so $8.4t - 4.9t^2 = 5.6t - 4.9t^2 + 2$ ① = ②

$\therefore 8.4t - 5.6t = 2$

$2.8t = 2$

$t = \frac{2}{2.8} = 0.7143$ secs.

so for p $v = u+at = 8.4 + (-9.8) \times 0.7143 = 1.39986$ m/s

q $v = u+at = 5.6 + (-9.8) \times 0.7143 = -1.40014$ m/s

to 2 sf speeds are the same but opposite directions

6. $s = 0.001t^4 - 0.04t^3 + 0.6t^2 \qquad 0 \le t \le 10.$

(i) $\therefore v = \frac{ds}{dt} = 0.004t^3 - 0.12t^2 + 1.2t$

When $t = 10 \quad v = 4 - 12 + 12 = 4$ m/s

(ii) $t \ge 10 \quad a = 0.8 - 0.08t$

$\therefore v = 0.8t - 0.08\frac{t^2}{2} + c$

when $t = 10$ this should be 4 m/s to match (i)

$\therefore v = 8 - 4 + c = 4 \quad$ so $c = 0$

$\therefore$ when $t = 20 \quad v = 16 - 16 = 0$ m/s

(iii) $s = 0.8\frac{t^2}{2} - 0.04\frac{t^3}{3} + k \qquad t \ge 10$

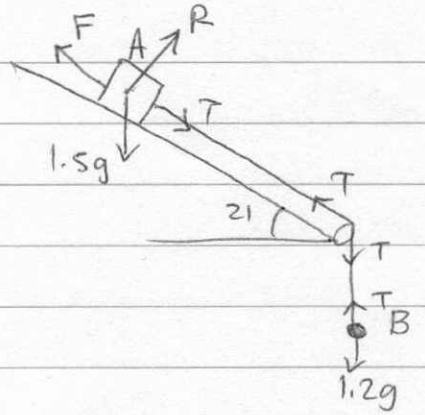
for $0 \le t \le 10$ using $s = 0.001t^4 - 0.04t^3 + 0.6t^2$

gives $s = 10 - 40 + 60 = 30$ m

from (ii) when $t = 10 \quad k = 3\frac{1}{3}$

so for $t = 20 \quad s = 56\frac{2}{3} \quad \therefore$ total $s = 86\frac{2}{3}$ m.

7.




$\mu = 0.8$

(i) on Block A $R = 1.5g\cos 21$

$F = \mu R = 0.8 \times 1.5g\cos 21$

$\therefore F = 10.9789\ldots$ N

$\therefore F = 10.98$ N (2dp)

(ii) $F = \mu R$

on (B) using "$F = ma$"

$1.2g - T = 1.2a$

on (A) using "$F = ma$"

$T + 1.5g\sin 21 - F = 1.5a$

$\therefore T = 1.2(g - a) \Rightarrow$

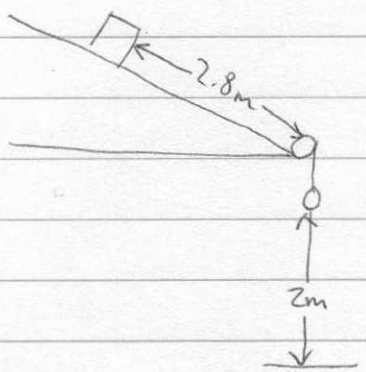
and $T = 1.5(a - g\sin 21) + 10.98$

(iii) $1.2g - 1.2a = 1.5a - 1.5g\sin 21 + 10.98$

$\therefore 2.7a = 6.048$

$a = 2.24$ m/s$^2$ (2dp)

(iv)




If $a = 2.24$ m/s$^2$

$s = 2$m

$u = 0$

(a) $\therefore v^2 = u^2 + 2as$

$v^2 = 2 \times 2.24 \times 2$

$\therefore v = 2.99$ m/s

Speed of block and object are equal.

(b) when the object reaches the floor tension in string disappears & block still has 0.8 m to reach the pulley.

so $-F + 1.5g\sin 21 = 1.5a$

$\therefore -10.98 + 1.5g\sin 21 = 1.5a$

$\therefore a = -3.808$ m/s$^2$

using $u = 2.99$ $a = -3.808$ $s = 0.8$

$v^2 = u^2 + 2as$

$v^2 = 2.8473$

$\therefore v = 1.687$ m/s. when block reaches the pulley.