Answers and marking scheme to the preliminary test. Physics I, UNSW

QUESTION 1 **[Marks 10]**

A stone is projected almost vertically upwards from the top of a building 78.4 m high with an initial velocity of 29.4 ms^{-1}. On its return flight it just misses the building and it reaches the ground near the base. Determine:

(a) the time for the stone to reach the highest point of its path;

(b) the maximum height reached in the path;

(c) the total time of flight; and

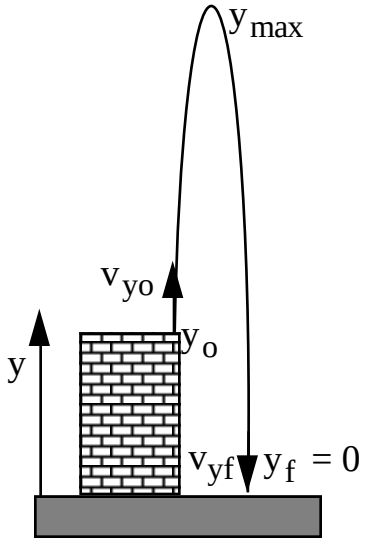
(d) the velocity of the stone just before it hits the ground.

Take up as the positive y direction. Because we are not told otherwise, we assume this happens on the Earth's surface. So,

acceleration is down: $a_y = -9.8\ ms^{-2}$.

"Almost vertically" means that

v_x is negligible throughout.



a) Max height is achieved when $v_y = 0$

$v_y = v_{oy} + a_y t$ so

$0 = v_{oy} + a_y t$ ✓

$t = -\frac{v_{oy}}{a_y} = -\frac{29.4\ ms^{-1}}{-9.8\ ms^{-2}} = 3.0\ s$ ✓

b) $y = y_o + v_{yo}t - \frac{1}{2}a_y t^2$. At t = 3.0 s, ✓

$y = 78.4 + 29.4*3.0 - \frac{1}{2}9.8*3.0^2$ ✓

$= 44\ m$ ✓ (*only 3 sig figs unless you used g to 3 sig figs*)

c) $y = y_o + v_{yo}t - \frac{1}{2}a_y t^2$. Finally, $y_f = 0$, so

$0 = y_o + v_{yo}t - \frac{1}{2}a_y t^2$ ✓

$t_f = \frac{-v_{yo} \pm \sqrt{v_{yo}^2 + 4*\frac{1}{2}a_y*y_o}}{a_y}$ ✓ Only the t > 0 solution is relevant*, so ✓

$t_f = 8.0\ s$ ✓

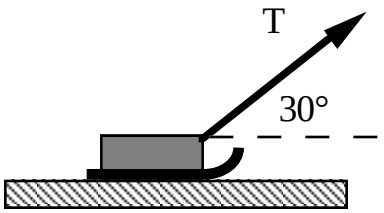
* *The t < 0 solution is the time at which you would have to throw the ball so that it passed the top of the building, going upwards at at 2m.4 m/s, at t = 0.*

d) $v_y = v_{oy} + a_y t$

$= -49\ m.s^{-1}$ ✓ *or* ball is travelling. 49 $m.s^{-1}$ downwards.

QUESTION 2 **[Marks 10]**

A sled of mass 20 kg is being pulled across a horizontal surface by means of a rope, as shown in the diagram. The rope makes an angle of 30° with the horizontal, and the tension in the rope is T = 196 N. The coefficient of sliding friction between the sled and the surface is 0.20.



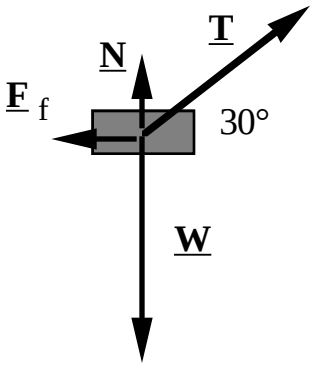
(a) Draw in all the forces acting on the sled in a diagram.

(b) Calculate the normal force between the horizontal surface and the sled.

(c) Calculate the force of friction on the sled.

(d) Calculate the acceleration of the sled.

a) See diagram at right



b) *The sled is moving horizontally, so the* vertical accel^{n} is zero, so $\Sigma \underline{\mathbf{F}}_y = 0$ so ✓

$N + T \sin 30° - W = 0$ ✓

$N = W - T \sin 30° = mg - T \sin 30°$

$= 98$ N

$\underline{\mathbf{N}}$ = 98 N up ✓ ✓ ✓ ✓

c) *For kinetic friection,* $F_f = \mu_k N = 0.20 * 98$ N, so

$\underline{\mathbf{F}}_f$ = 20 N to the left. ✓

d) *Acceleration is only horizontal, so*

$a = a_x = \Sigma F_x / m$ *by Newton's 2nd law, so* ✓

$$a = \frac{T \cos 30° - F_f}{m} = 7.5 \text{ ms}^{-2}$$ ✓

$\underline{\mathbf{a}}$ = 7.5 ms^{-2} to the right. ✓