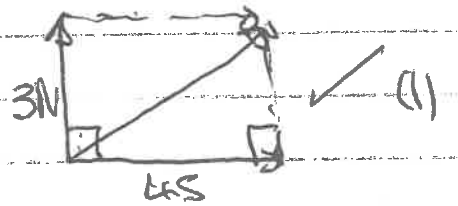
PHY111 Term Test 1 25 March 2023

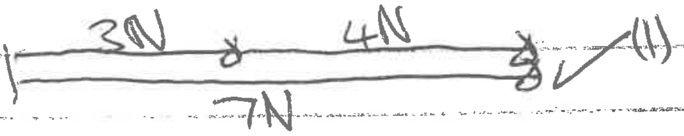
Sample solutions

Question 1

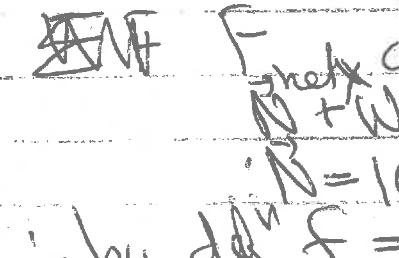
1.1.1 The force vectors 3N and 4N have a sum of 5N if they act perpendicular to each other as shown in sketch. ✓(1)

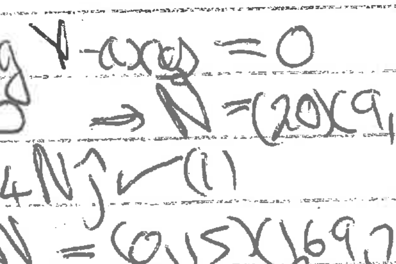


1.1.2 The force vectors 3N and 4N cannot have a sum of 8N because they max sum is 3N+4N=7N ✓(1) as shown in sketch ✓(1)



1.2





$\vec{F}_{net}$ along Y-axis $= 0$

$\vec{N} + \vec{W}_{\perp} = 0 \Rightarrow N = (20)(9,8)\cos 30$

$\therefore N = 169,74 N \hat{j}$ ✓(1)

$\therefore$ by defn $f = \mu N = (0,15)(169,74N) = 24,46N$ ✓(1)

$\vec{F}_{net}$ along X-axis $= \vec{W}_{\parallel} + \vec{f} + \vec{F}$

$= (20)(9,8)\sin 30(-\hat{i}) + (24,46(-\hat{i})) + 100\hat{i}$

$= 22,46N(-\hat{i})$ ✓(1)

The 100N cannot move box up inclined plane ✓(1) according to Newton's Second law of motion

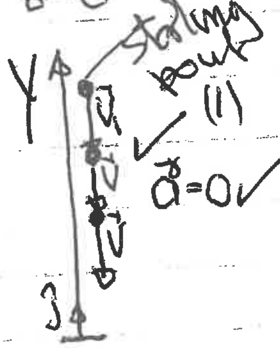
Question 2

2.1 The statement is correct ✓(1) because the speedometer only indicate the speed ✓(1) of the car at any time t, i.e. magnitude of the velocity.

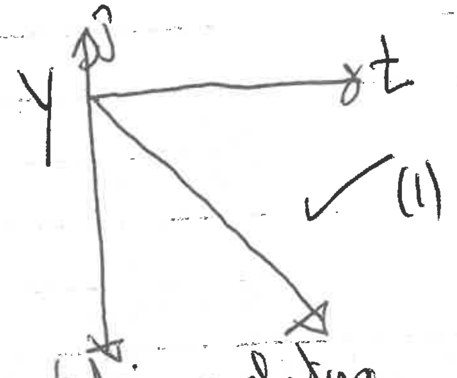
2.2.1 Yes an object acceleration can be non zero while its velocity is zero. ✓(1)

2.2.2 An object going forward ✓(1) and then turn around and move backward along same direction as shown in sketch

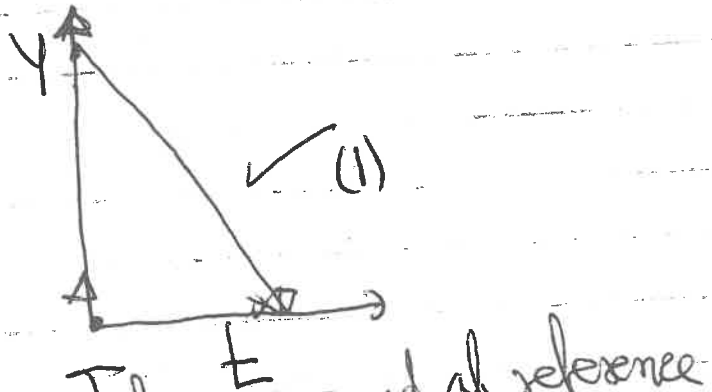
2.3.1



2.3.2



or



2.4 $\vec{a}_y = -9{,}8\ ms^{-2}\hat{j}$ and $\vec{v}_0 = 29{,}4\ ms^{-1}\hat{j}$ at $t = 0$ ✓

$\vec{v}_1 = 29{,}4 - 9{,}8 = 19{,}6\ ms^{-1}\hat{j}$ at $t = 1s$

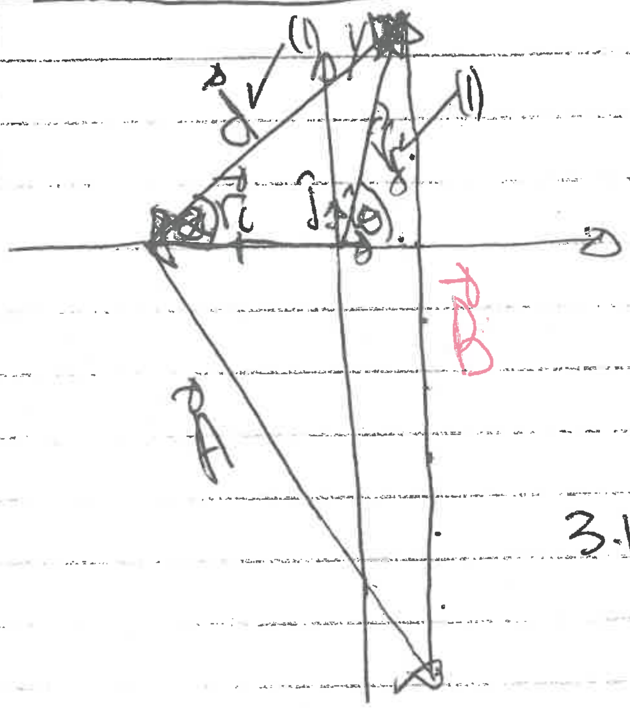
$\vec{V}_2 = 19{,}8 - 9{,}8 = 10\ ms^{-1}\hat{j}$ at $t = 2s$

$\vec{V}_3 = 10 - 9{,}8 = 0{,}2\,ms^{-1}\hat{j}$ at $t = 3s$ ✓

The object will take approximately 3s to reach its maximum height. ✓

Question 3

3.1



3.1.1 $\vec{d} = \vec{A} + \vec{B}$

$= (3\hat{i} + 6(-\hat{j})) + (0\hat{i} + 10\hat{j})$

$= 3\hat{i} + 4\hat{j}$

$d = \sqrt{(3)^2 + (4)^2} = 5m$

$\tan\alpha = \frac{4}{3}$ $\alpha = 53{,}1°$

$\vec{d} = (5m, 53{,}1°)$ ✓✓ (2)

3.1.2 $\vec{r}_f - \vec{r}_i = \vec{d} = \vec{A} + \vec{B}$

$\vec{r}_f = \vec{A} + \vec{B} + \vec{r}_i$

$= (3\hat{i} + 4\hat{j}) + (2(-\hat{i}) + 0\hat{j})$

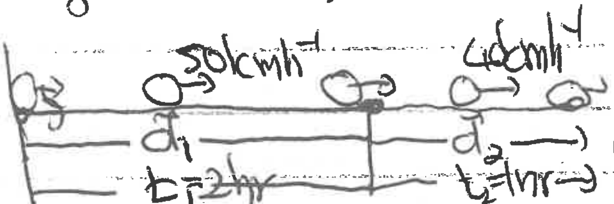
$= 1\hat{i} + 4\hat{j}$

$r_f = \sqrt{(1)^2 + (4)^2} \approx 4{,}12\,m$

$\tan\theta = \frac{4}{1}$, $\theta = 75{,}96°$

$\vec{r}_f = (4{,}12m, 75{,}96°)$ ✓✓ (2)

3.3



✓ (1)

$\vec{d}_1 = (50\,kmh^{-1})(2hr) = 100\,km\,\hat{i}$

$\vec{d}_2 = (40\,kmh^{-1})(1hr) = 40\,km\,\hat{i}$

$\vec{V}_a = \frac{\vec{d}_1 + \vec{d}_2}{t_1 + t_2}$

$= \frac{(100 + 40)\,km\,\hat{i}}{(2 + 1)\,hr}$ ✓(1)

$= 46{,}7\,kmh^{-1}\,\hat{i}$ ✓(1)

The car's average velocity is $46{,}7\,kmh^{-1}$, East ✓(1)

4

Question 4

4.1.1 $\vec{V}(t) = \frac{d}{dt}(3\hat{i} + 5t\hat{j} + 4,9t^2(-\hat{j})) = 5\hat{j} + 9,8t(-\hat{j})$

$\vec{a}(t) = \frac{d}{dt}(5\hat{j} + 9,8t(-\hat{j})) = 9,8\,ms^{-2}(-\hat{j})$ (1)

The object is undergoing uniform accelerated motion. since a(t) independent of time, ie a(t) is constant (1)

4.1.2 $\vec{V}(t) = 5\hat{j} + 9,8t(-\hat{j})$ (1) (1)

at $t = 0,75\,s$ $\vec{V}(0,75) = 5\hat{j} + 9,8(0,75)(-\hat{j}) = 2,35\,ms^{-1}(-\hat{j})$

I agree ~~w~~ with Evidence since the $2,35\,ms^{-1}$ is downwards, in the direction of starting point.

4.2 $V(t) = V(0) + \int_0^t a(t)\,dt$

$= (10) + \int (6-3t)\,dt$

$= 10 + 6t - \frac{3}{2}t^2$ (1)

at max height $V(t) = 0$ (1)

$10 + 6t - \frac{3}{2}t^2 = 0$

$20 + 12t - 3t^2 = 0$

$t = \frac{-(12) \pm \sqrt{(12)^2 - 4(-3)(20)}}{2(-3)} = \frac{-12 \pm \sqrt{144+240}}{-6}$ (1)

$t = -1,27\,s$ or $5,27\,s$ (1)

(1)

The ball takes 5,27 s to reach its max height.

Questions

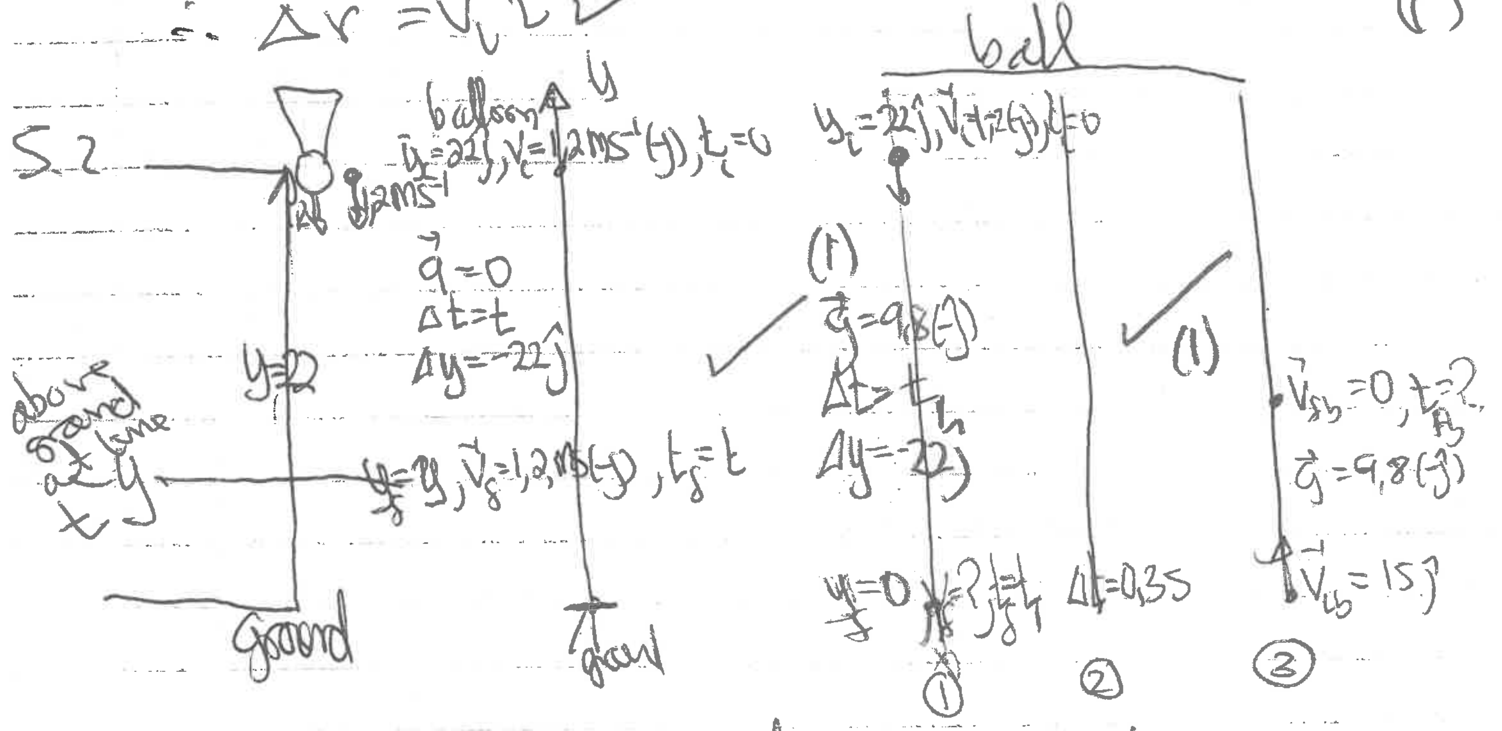
5.1.1 Yes I agree. ✓ (1)

5.1.2 $\Delta\vec{r} = \vec{v}_i\Delta t + \frac{1}{2}\vec{a}\Delta t$, for uniform motion

$\vec{a} = 0$

$\therefore \Delta\vec{r} = \vec{v}_i t$ ✓ (1)

5.2



The time above ground $= t + 0,3s + t_{fb}$

time t for ball to reach ground (ball ①)

$\Delta\vec{y} = \vec{v}_i\Delta t + \frac{1}{2}\vec{g}\Delta t$ ✓ (1)

$(-22\hat{j}) = (1,2(-\hat{j}))(t) + \frac{1}{2}(9,8(-\hat{j}))(t)^2$

$\therefore 4,9t^2 + 1,2t - 22 = 0$

$t = \dfrac{-(1,2) \pm \sqrt{(1,2)^2 - 4(4,9)(-22)}}{2(4,9)} = 2s$ ✓ (1) or - - -

time t_{fb} for first bounce:

$\vec{v}_{fb} = \vec{v}_{ib} + \vec{g}\Delta t$ ✓ (1)

$(0) = (15\hat{j}) + \partial(9,8(-\hat{j}))(t_{fb}) \rightarrow t_{fb} = \frac{-15}{-9,8} = 1,53s$ ✓ (1)

time above ground $t = 2 + 0,3 + 1,53 = 3,83s$

ball height above ground: $\Delta\vec{y}_b = \vec{v}_{ib}\Delta t + \frac{1}{2}\vec{a}_y\Delta t$ ✓ (1)

$y - 22m\hat{j} = (1,2(-\hat{j}))(3,83s) + \frac{1}{2}(0)(3,83)^2$ ✓ (1)

$\therefore y = (22 - 4,60)\hat{j} = 17,4m\hat{j}$ $\therefore$ height above ground is 17,4m