National University of Computer and Emerging Sciences (NUCES), Lahore Campus				
	Course:	Applied Physics	Course Code:	NS1001
	Program:	BS(CS), BS(DS) & BS (SE)	Semester:	Fall 2023
	Duration:	60 minutes	Total Marks:	35
	Date:	02-10-2023	Weight:	15%
	Section(s):	All	Page(s):	3
	Exam:	Midterm 1	Section	[redacted]
	Name:	[redacted]	Roll No.	[redacted]
Instructions/Notes:	Write your answer within the space provided only. You can take rough sheet, but do not attach it with the paper. The value of Gravitational constant, g =9.8 m/s²			

35/35

Question 1 (a): For two decades spelunking teams crawled, climbed, and squirmed through 200 km of Mammoth Cave and the Flint Ridge cave system, seeking a connection. The team that finally found the connection "caved" for 12 hours to go from Austin Entrance in the Flint Ridge system to Echo River in Mammoth Cave (see **Figures a & b**), traveling a net 2.6 km westward, 3.9 km southward, and 25 m upward. That established the system as the longest cave system in the world. What were the magnitude and angle of the team's displacement from start to finish? Also, mention the vectors where question marks are mentioned in **Figure c.** **(7 marks)**

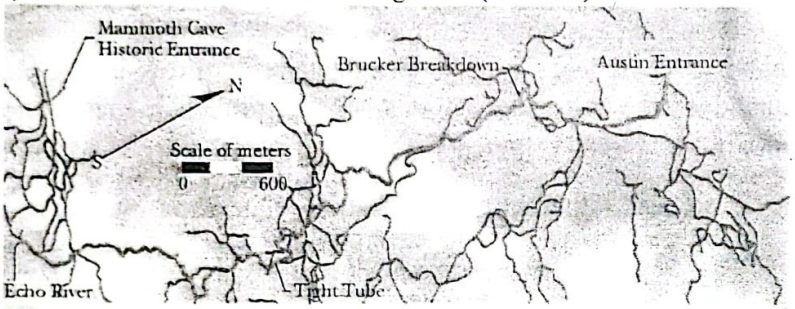


Figure a

~~2.6i~~

Magnitude = $\sqrt{2.6^2 + 3.9^2 + 0.025^2}$

$= 4.69$ km

Angle $\Rightarrow \theta_h = \tan^{-1}\left(\frac{3.9}{2.6}\right) =$ 56.3° South of west.

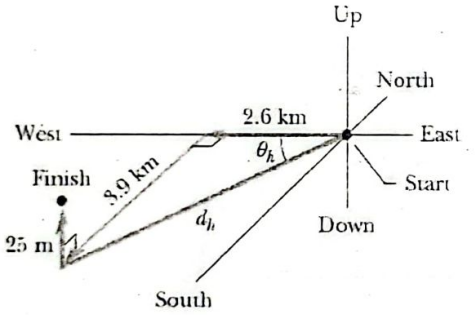
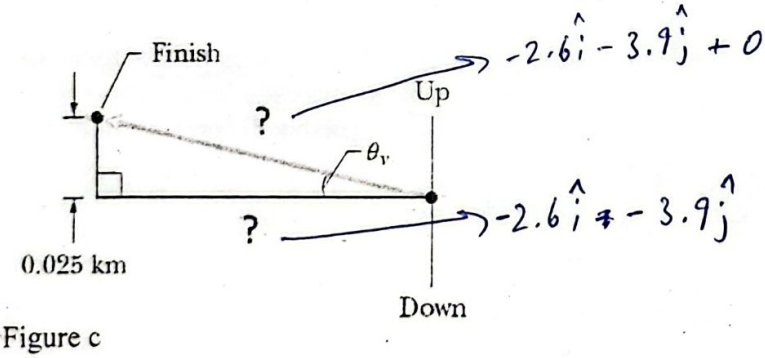


Figure b

$\theta_v = \tan^{-1}\left(\frac{0.025}{4.687}\right) = 0.31°$

and

0.31° upwards from start



$-2.6\hat{i} - 3.9\hat{j} + 0.025\hat{k}$

$-2.6\hat{i} - 3.9\hat{j}$

Figure c

Question 1 (b): Analyze a projectile's vertical motion by considering all three equations of motion. **(6 marks)**

1- $v_y = v_0 \sin\theta_0 - gt$

2- $y - y_0 = v_0 \sin\theta_0 t - \frac{1}{2} g t^2$

3- $v_y^2 = (v_0 \sin\theta_0)^2 - 2g(y - y_0)$

Put (1) and (2) in (3):-

$(v_0 \sin\theta_0 - gt)^2 = v_0^2 \sin^2\theta - 2g(v_0 \sin\theta_0 t - \frac{1}{2} g t^2)$

$v_0^2 \sin^2\theta_0 - 2v_0 \sin\theta_0 gt + g^2 t^2 = v_0^2 \sin^2\theta - 2g v_0 \sin\theta_0 t - g^2 t^2$

1- $v = u + at$ 2- $s = ut + \frac{1}{2} a t^2$

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

$\therefore H = \frac{v_0^2 \sin^2\theta}{2g}$

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$H = \frac{v_0^2 \sin^2\theta}{2g}$

Question 1(c): In a conventional soccer throw-in, the player has both feet on the ground on or outside the touch line, brings the ball back of the head with both hands, and launches the ball. In a handspring throw-in, the player rapidly executes a forward handspring with both hands on the ball as the ball touches the ground and then launches the ball upon rotating upward (**Figures c & d**). For both launches, take the launch height to be $h_1 = 1.92$ m and assume that the ball is intercepted by a teammate's forehead at height $h_2 = 1.71$ m. Use the experimental results that the launch in a conventional throw-in is at angle $\theta_0 = 28.1°$ and speed $v_0 = 18.1$ m/s and in a handspring, throw-in is at angle $\theta_0 = 23.5°$ and speed $v_0 = 23.4$ m/s. For the conventional throw-in, **what are (a) the flight time t_c and (b) the horizontal distance d_c traveled by the ball to the teammate? (7 marks)**

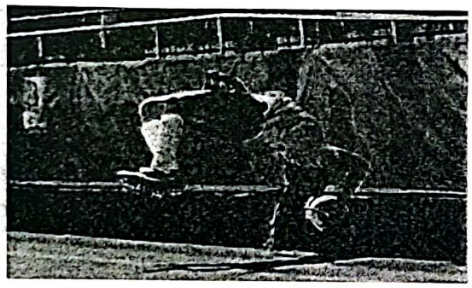

Figure c

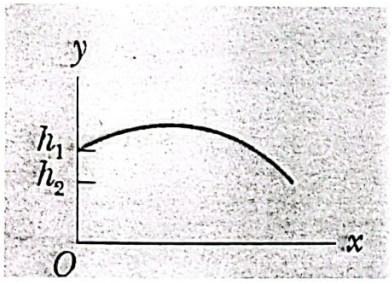

Figure d

a) $y - y_0 = v_0 \sin\theta_0 t + -\frac{1}{2} \times 9.8 \times t^2$

$1.71 - 1.92 = 18.1 \sin 28.1 t - \frac{1}{2} \times 9.8 \times t^2$

$t = 1.76$ s

b) $x - x_0 = v_0 \cos\theta_0 \times t$

$d_c = 18.1 \cos 28.1 \times 1.76$

$d_c = 28.1$ m

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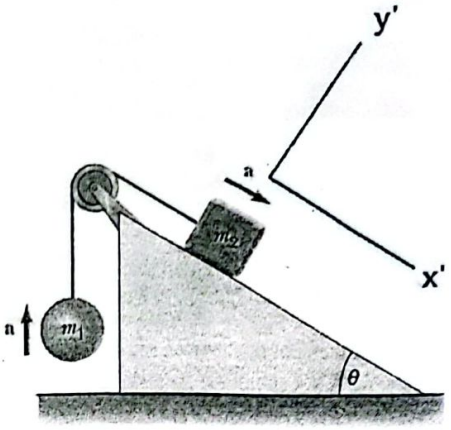
n 2 (a): ball of mass $m1$ and a block of mass $m2$ are attached by a light weight cord that passes over a less pulley of negligible mass, as in Figure below. The block lies on a frictionless incline of angle θ.

(i) Derive an expression for the acceleration of the two objects.

(ii) Draw free-body diagram for m_1 and m_2 separately.

(8+2 marks)



i) $W_2 - T = m_2 a$ — (1) $\Rightarrow T = W_2 - m_2 a$

$T - W_1 = m_1 a$ — (2) $\Rightarrow T = m_1 a + W_1$

Equating Both

$W_2 - m_2 a = m_1 a + W_1$

$W_2 - W_1 = a(m_1 + m_2)$

$a = \dfrac{W_2 - W_1}{m_1 + m_2}$

$W_2 = m_2 g \sin\theta$

$W_1 = m_1 g$

Sub W_2 and W_1 in eq.

$$a = \frac{m_2 g \sin\theta - m_1 g}{m_1 + m_2}$$

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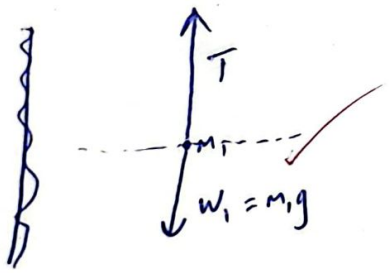
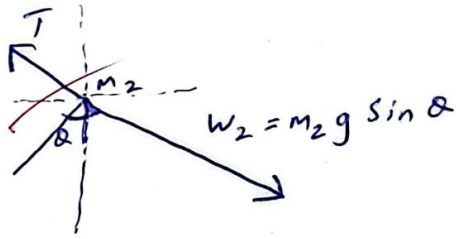
ii)





a is same.

Question 2(b): A 1.50 kg model helicopter has a velocity of [5.00 *j* (m/s)] at t=0. It is accelerated at a constant rate for 2 seconds after which it has a velocity of [(6 *i* + 12 *j*) m/s]. What is the magnitude of the resultant force acting on the helicopter during this time interval? **(5 marks)**

$$\vec{a} = \frac{\vec{v} - \vec{v}}{t} = \frac{6\hat{i} + 12\hat{j} - 5\hat{j}}{2} = \left[3\hat{i} + \frac{7}{2}\hat{j}\right] m/s^2$$

$$\vec{F} = m\vec{a} = 1.5 \times 3\hat{i} + 3.5\hat{j} = [4.5\hat{i} + 5.25\hat{j}]\ N$$

$$|\vec{F}| = \sqrt{4.5^2 + 5.25^2} = 6.91\ N$$

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