İzmir Kâtip Çelebi University
Department of Engineering Sciences
Phy101 Physics I
Midterm Examination
November 02, 2026 10:20 – 11:50
Good Luck!

NAME-SURNAME:

SIGNATURE:

ID:

DEPARTMENT:

INSTRUCTOR:

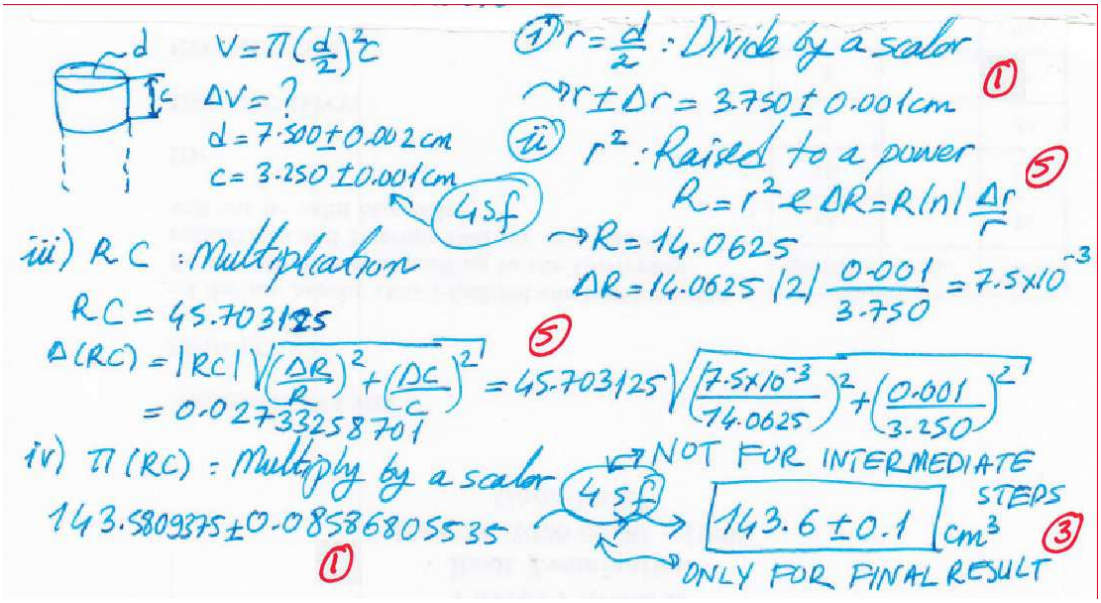
DURATION: 90 minutes

◇ **Answer all the questions.**
◇ **Write the solutions explicitly and clearly. Use the physical terminology.**
◇ **You are allowed to use Formulae Sheet.**
◇ **Calculator is allowed.**
◇ **You are not allowed to use any other electronic equipment in the exam.**

Question	Grade	Out of
1A		15
1B		20
2		15
3		15
4		20
5		15
TOTAL		100

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1. A) A car engine moves a piston with a circular cross section of $7.500 \pm 0.002\ cm$ diameter a distance of $3.250 \pm 0.001\ cm$ to compress the gas in the cylinder. By what amount is the gas decreased in volume in cubic centimeters? Find the uncertainty in this volume.



B) Three vectors are given as:

$$\vec{A} = \hat{i} - 5\hat{k}, \quad \vec{B} = 3\hat{i} - 2\hat{j}, \quad \vec{C} = 5\hat{i} + \hat{j} + \hat{k}$$

Find:

i $\vec{A} \cdot (\vec{B} + \vec{C})$,

ii $\vec{A} \cdot (\vec{B} \times \vec{C})$,

iii The angle between $\vec{A}$ and $\vec{B}$,

iv The angle between $\vec{A}$ and $\vec{A} \times \vec{B}$,

v If a particle's initial position vector is expressed by $\vec{A}$ and its final position vector by $\vec{C}$, calculate the displacement $\vec{d}$.

i. $\vec{A}.(\vec{B}+\vec{C})$ should be scalar

$\vec{B}+\vec{C} = 8\hat{i}-\hat{j}+\hat{k} \rightsquigarrow \vec{A}.(\vec{B}+\vec{C}) = 8-0-5 = 3$ (3)

ii. $\vec{A}.(\vec{B}\times\vec{C})$ should be scalar (2)

$\vec{B}\times\vec{C} = (B_y C_z - B_z C_y)\hat{i} + (B_z C_x - B_x C_z)\hat{j} + (B_x C_y - B_y C_x)\hat{k}$

$= ((-2)(1) - (0)(1))\hat{i} + ((0)(5) - (3)(1))\hat{j} + ((3)(1) - (-2)(5))\hat{k}$ (2)

$= -2\hat{i} - 3\hat{j} + 13\hat{k}$ (1)

$\rightsquigarrow \vec{A}.(\vec{B}\times\vec{C}) = -2 - 0 - 65 = -67$ (2)

iii. $\vec{A}.\vec{B} = |\vec{A}||\vec{B}|\cos\theta \rightsquigarrow |\vec{A}| = \sqrt{1^2+(-5)^2} = 5.10$

$|\vec{B}| = \sqrt{3^2+(-2)^2} = 3.61$ (2)

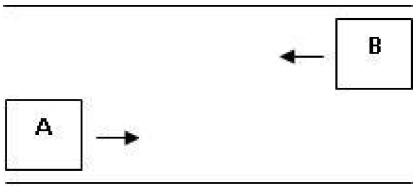
$\rightsquigarrow 3 = 5.10 \times 3.61 \times \cos\theta$ (2) $\vec{A}.\vec{B} = 3+0+0 = 3$

$\rightsquigarrow \cos\theta = \frac{3}{5.10 \times 3.61} = 0.16 \rightsquigarrow \theta = \cos^{-1} 0.16 = 80.6°$ (1)

iv. $\vec{A}$ and $\vec{A}\times\vec{B}$ is perpendicular

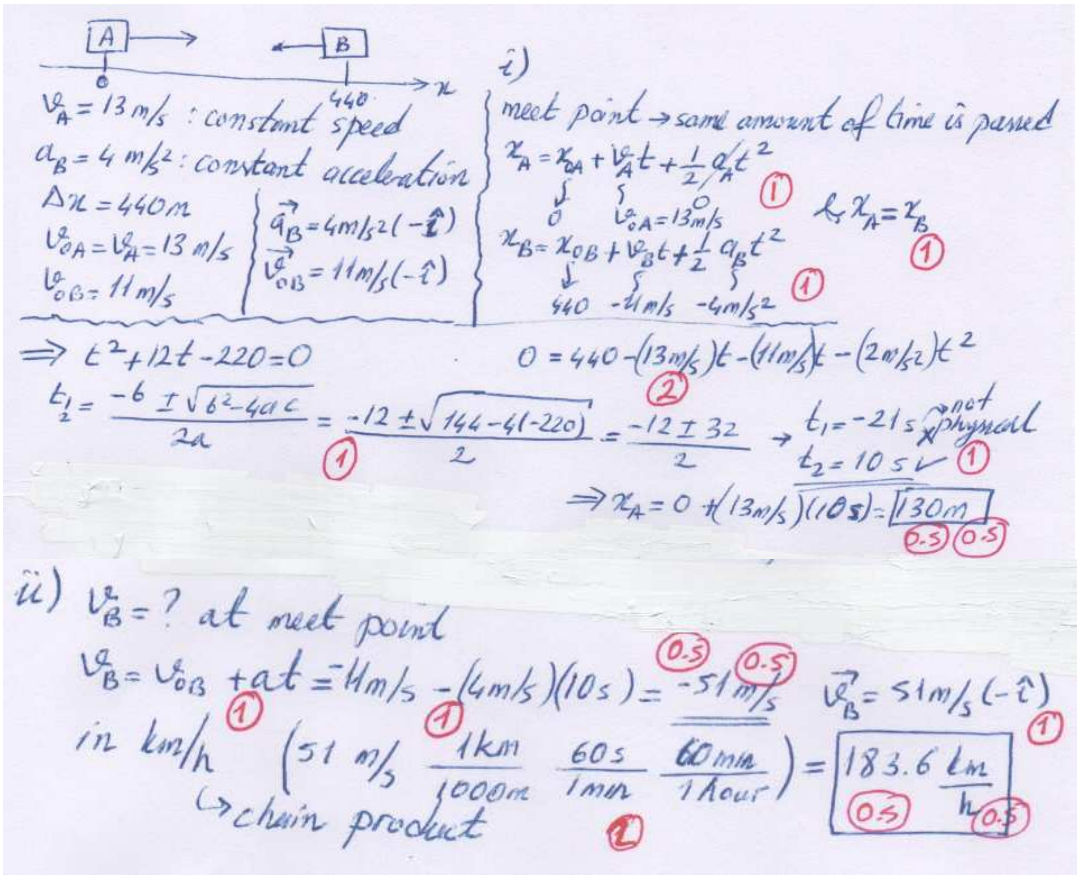
$\rightsquigarrow 90°$ (5)

2. Two cars are travelling in opposite directions along straight lines; car **A** with constant speed of 13 m/s, and car **B** with constant acceleration of 4 m^2/s. Assume that initial distance between the cars is 440 m and initial speeds of car **A** and car **B** are 13 m/s and 11 m/s, respectively.

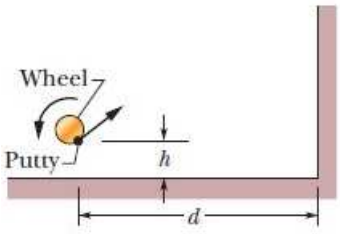


i Calculate the meet point of cars with respect to initial position of car **A**,

ii Determine the speed of car **B** in km/h at the meet point.



3. In Figure, an object (putty in the figure) moves in uniform circular motion as it rides at a radius of 20.0 cm on the edge of a wheel rotating counterclockwise with a period of 5.00 ms.



The object then happens to fly off the edge at angle of 30° with horizontal axis. It leaves the edge at a height of $h = 1.20\ m$ from the floor and at a distance $d = 2.50\ m$ from a wall. At what height on the wall does the object hit?

$T = \frac{2\pi R}{v} = 5\times10^{-3}\,s$ (2) $\rightsquigarrow v = \frac{2\pi R}{T} = \frac{2\pi\, 20\times10^{-2}\,m}{5\times10^{-3}\,s} \simeq 251\,m/s$

$a = \frac{v^2}{R}$ & $R = 20\times10^{-2}\,m$

rotates ccw

$\theta = 30°$ & $h = 1.2m$ & $d = 2.5m$

(2) v_0, θ, h, H, FLOOR, d

① $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$ (2)

② $x = x_0 + v_{0x}t$ (2)

② $x - x_0 = d = 2.5m$ (3)

$\rightsquigarrow t = \frac{2.5m}{251m/s\,\cos 30} = 0.012s$

$\rightsquigarrow$ ① $y - y_0 = H - h = v_0 \sin\theta\, t - \frac{1}{2}gt^2$

$H - h = 251m/s\,\sin 30\,(0.012s) - \frac{1}{2}\,9.8m/s^2\,(0.012s)^2 \Rightarrow 1.44m$ (2)

$\rightsquigarrow H = 1.44m + 1.2m = \boxed{2.64m}$ (2)

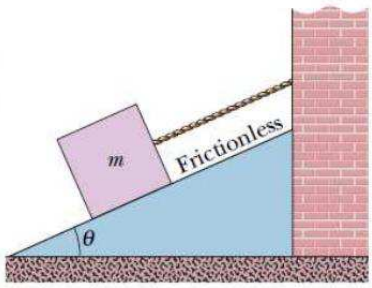
4. In Figure, let the mass of the block be 8.5 kg and the angle be 30°.

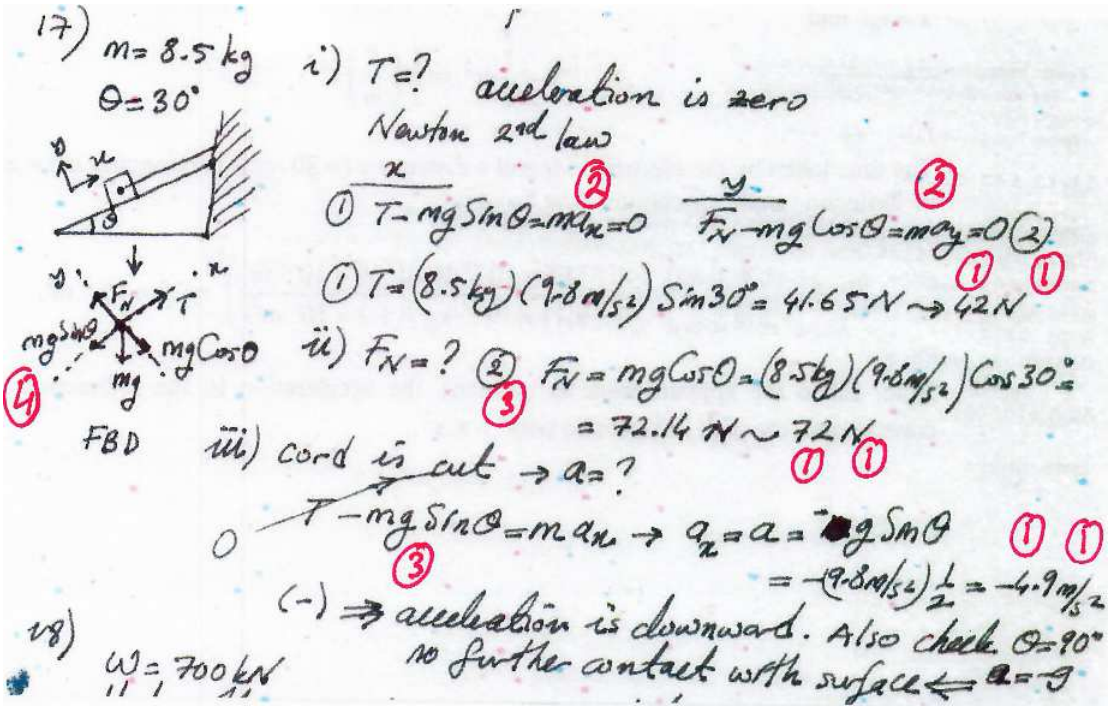
Find

i the tension in the cord,

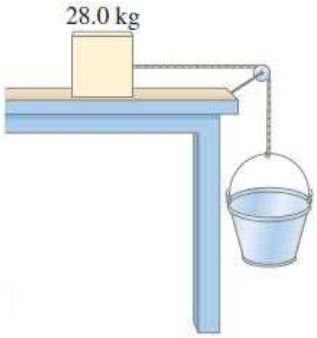
ii the normal force acting on the block,

iii If the cord is cut, find the magnitude of the resulting acceleration of the block.





5. A 28.0 kg block is connected to an empty 2.00 kg bucket by a cord running over a frictionless pulley as shown in the figure.

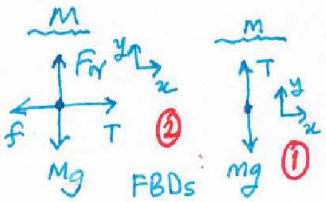


The coefficient of static friction between the table and the block is 0.45 and the coefficient of kinetic friction between the table and the block is 0.32. Sand is gradually added to the bucket until the system just begins to move.

i Calculate the mass of sand added to the bucket.

ii Calculate the acceleration of the system.

$M = 28\,kg$
$m = 2\,kg$
$\mu_s = 0.45$
$\mu_k = 0.32$



initially stationary.
T will increase by adding sand.
f_s will increase up to $f_{s,max} (= \mu_s F_N)$
Then the system will start to move.

i) Equations of motion (Newton's 2nd law)

M
x: $\Sigma F_x = T - f_s = Ma_{x,M}$ ①
y: $\Sigma F_y = F_N - Mg = Ma_{y,M}$ ①②

m
y: $\Sigma F_y = -mg + T = -ma_{y,m}$ ③①

no motion & $f_{s,max}$:
① $T - f_{s,max} = 0 \rightarrow T = \mu_s F_N$
② $F_N - Mg = 0 \rightarrow F_N = Mg$
③ $T - mg = 0 \rightarrow T = mg$
④ $f_{s,max} = \mu_s F_N$ ①

$\mu_s (Mg) = mg \rightarrow m = \mu_s M = (0.45)(28\,kg) = 12.6\,kg$

which is $m_{bucket} + m_{sand} = 12.6\,kg \rightarrow m_{sand} = 12.6\,kg - 2\,kg = \boxed{10.6\,kg}$ ① ①

ii) now, we have motion as: $a_{x,M} = a_{y,m} = a$ & $f_k = \mu_k F_N$ ②

① $T - f_k = Ma$
③ $-T + mg = ma$
④ $f_k = \mu_k F_N$

$m(g - a) - \mu_k F_N = Ma \rightarrow \frac{mg - \mu_k Mg}{(M+m)} = a$ ②

$a = \frac{12.6\,kg - 0.32(28\,kg)\,9.8\,m/s^2}{(28\,kg + 12.6\,kg)} = \boxed{0.88\,m/s^2}$ ① ①