İZMİR KATİP ÇELEBİ UNIVERSITY	FACULTY OF ENG. & ARCH. PHY101, MIDTERM EXAM 2nd November 2019, 11:00, DURATION: 120 MIN			
Student Name	**ID Number**	**Instructor Name**	**Department**	**Signature**

Please read the following directions carefully.

- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct).
- Write neatly and clearly; unreadable answers will not be given any credit. If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- Make sure that you include units in your results. Incomplete calculations will not be graded.
- Turn off your mobile phones, and put away. No notebooks or textbooks are allowed to use during the exam.
- You are not allowed to leave the class during the first 15 minutes, and last 15 minutes.
- Calculator is allowed to use. Calculator is assumed to be used only for simple arithmetics, other intentions will be considered as cheating. Everybody must use his/her own calculator. Do not exchange calculators during the exam!
- There are 5 questions. Grade point values are under question numbers.
- Before you begin, please check all pages.
- At the end of the exam, make sure that you turn in your exam paper to your proctor by yourself! Do not give your exam paper to others!

1 (20pts)	2 (20pts)	3 (20pts)	4 (20pts)	5 (20pts)	Total grade

This page can be used if necessary.

QUESTIONS
(Put your solutions under each question!)

1. A rectangular piece of copper is 6.43 ± 0.02 cm long and 1.50 ± 0.01 cm wide. **(a)** Find the area of the rectangle and the uncertainty in the area. **(b)** Find the perimeter of the rectangle with the uncertainty? **(c)** Find the difference between the length and width with the uncertainty? (Express the answers with the correct number of significant figures)

a) The area of the copper = Length × width ; $L = 6.43 \pm 0.02$ cm, $w = 1.50 \pm 0.01$ cm

$A = L \times w$

$A = A_{best} \pm \Delta A$ (2)

$A_{best} = 6.43 \times 1.50 = 9.65 \text{ cm}^2$ (2)

$$\frac{\Delta A}{A_{best}} = \sqrt{\left(\frac{\Delta L}{L_{best}}\right)^2 + \left(\frac{\Delta w}{w_{best}}\right)^2} \Rightarrow \frac{\Delta A}{9.65 \text{ cm}^2} = \sqrt{\left(\frac{0.02}{6.43}\right)^2 + \left(\frac{0.01}{1.50}\right)^2} \Rightarrow \Delta A = 0.07 \text{ cm}^2$$ (3)

$A = 9.65 \pm 0.07 \text{ cm}^2$ (1)

b) Perimeter of the rectangle $= 2L + 2w$; $2L = 2(6.43 \pm 0.02 \text{ cm}) = (12.86 \pm 0.04 \text{ cm})$ (1)

$P = 2L + 2w$; $2w = 2(1.50 \pm 0.01 \text{ cm}) = (3 \pm 0.02 \text{ cm})$ (1)

$P = (12.86 \pm 0.04 \text{ cm}) + (3 \pm 0.02 \text{ cm})$

$P_{best} = 12.86 + 3 = 15.86$ cm (1)

$\Delta P = \sqrt{\Delta L^2 + \Delta w^2} = \sqrt{(0.04)^2 + (0.02)^2} = 0.04$ cm (2)

$P = P_{best} + \Delta P = 15.86 \pm 0.04$ cm (1)

c) $L - w = (6.43 \pm 0.02 \text{ cm}) - (1.50 \pm 0.01 \text{ cm})$

$D = (L - w)_{best} = 6.43 - 1.50 = 4.93$ cm (2)

$\Delta D = \sqrt{(\Delta L)^2 + (\Delta w)^2} = \sqrt{(0.02)^2 + (0.01)^2} = 0.02$ cm (3)

Difference $= 4.93 \pm 0.02$ cm (1)

2. The height of a helicopter above the ground is given by $h = 3.00\ t^3$, where h is in meters and t is in seconds. Therefore, its position in the vertical direction changes as a function of time. After 2.00 seconds of vertical flight, the helicopter releases a small mailbag. How long after its release does the mailbag reach the ground?

$y = 3.00t^3$: At $t = 2.00$ s, $y = 3.00(2.00)^3 = 24.0$ m and 5

$$v_y = \frac{dy}{dt} = 9.00t^2 = 36.0\ \text{m/s}\uparrow.$$ 5

If the helicopter releases a small mailbag at this time, the equation of motion of the mailbag is

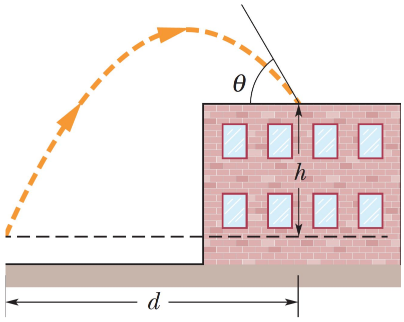
$$y_b = y_{bi} + v_i t - \frac{1}{2}gt^2 = 24.0 + 36.0t - \frac{1}{2}(9.80)t^2.$$ 5

Setting $y_b = 0$,

$$0 = 24.0 + 36.0t - 4.90t^2.$$ 3

Solving for t, (only positive values of t count), $\boxed{t = 7.96\ \text{s}}$. 2

3. In Figure below, a ball is thrown up onto a roof, landing 4.00 s later at height $h = 20.0\ m$ above the release level. The ball's path just before landing is angled at $\theta = 60.0°$ with the roof. (a) Find the horizontal distance *d* it travels. What are the (b) magnitude and (c) angle (relative to the horizontal) of the ball's initial velocity? Take g=9.8 m/s^2. (**Hint:** This is time-reversed problem! Assume that the ball is thrown from the roof, toward the left, at 60° measured clockwise from a leftward axis.)



Following the hint, it is convenient to take +x as leftward with positive angles measured clockwise.

a)

$$y - y_0 = v_{0y} t - \frac{1}{2} g t^2 \ (2) \implies v_0 = 16.9\ m/s \ (1)\ (1)$$

$y = 0$, y_0: 20 m, $v_{0y} = v_0 \sin 60$

$$x - x_0 = v_{0x} t \ (1) \longrightarrow d = 33.7\ m \ (1)\ (1)$$

x: d, x_0: 0

b)

$$v_x = v_{0x} = (16.9)(\cos 60) = 8.43\ m/s \ (1)\ (1)\ (1)\ (1)$$

$$v_y = v_{0y} - g t \ (2) = (16.9) \sin 60 - (4.8)(4) = -24.6\ m/s$$

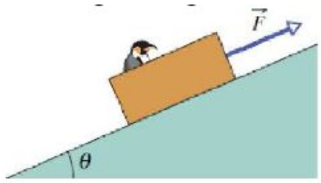
The magnitude of $\vec{v}$ is $|\vec{v}| = \sqrt{v_x^2 + v_y^2}\ (2) = \sqrt{(8.43)^2 + (-24.6)^2} = 26\ m/s$ (2) (1)

c) The angle relative to horizontal is

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) \ (2) = \tan^{-1}\left(\frac{-24.6}{8.43}\right) = -71.1° \ (1)$$

And we now interpret our result ("undoing" the time reversal) as an initial velocity of magnitude 26 m/s with angle (up from rightward) of 71.1°.

4. A loaded penguin sled weighing 80 N rests on a plane inclined at an angle θ = 20° to the horizontal (see Figure). Between the sled and the plane, the coefficient of static friction is 0.25, and the coefficient of kinetic friction is 0.15.



i) What is the least magnitude of the force |**F**| parallel to the plane, that will prevent the sled from slipping down the plane?
ii) What is the minimum magnitude |**F**| that will start the sled moving up the plane?
iii) What value of |**F**| is required to move the sled up the plane at constant velocity?

$W = 80\,N$, $\theta = 20°$, $\mu_s = 0.25$, $\mu_k = 0.15$

i) prevent slipping down → no motion, F_{min}?

x: $F + f - W\sin 20 = m a_x = 0$
y: $F_N - W\cos\theta = m a_y = 0$
where $f = f_{s,max}$

$F_N = W\cos\theta$; $f_{s,max} = \mu_s F_N = \mu_s W\cos\theta$

→ $F = W\sin 20 - \mu_s W\cos 20$
$= 80N(\sin 20 - 0.25\cos 20) = 8.57\,N$

ii) start to moving up → no motion, F_{min} = ?

x: $F - f - W\sin 20 = 0$
y: $F_N - W\cos 20 = 0$
$f = f_{s,max} = \mu_s F_N$

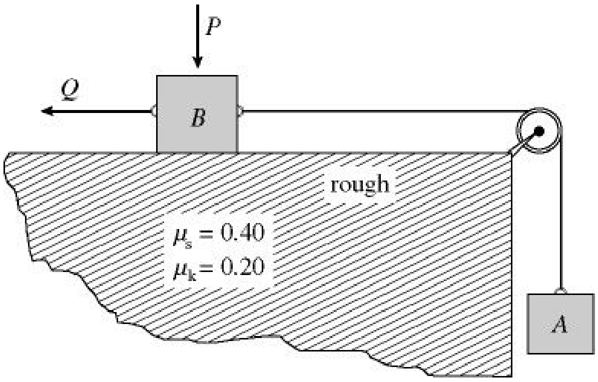
$F = f + W\sin 20 = \mu_s W\cos 20 + W\sin 20$
$= W(\mu_s\cos 20 + \sin 20) = 80N(0.25\cos 20 + \sin 20)$
$= 46.16\,N$

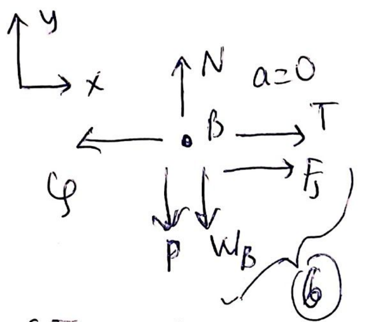
iii) move up, constant velocity → motion. F = ? a = 0

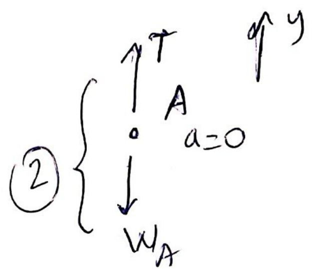
$F - \mu_k F_N - W\sin 20 = m a_x = 0$
$F - \mu_k W\cos 20 - W\sin 20 = 0$

$F = W(\mu_k\cos 20 + \sin 20)$
$= 80\,N(0.15\cos 20 + \sin 20)$
$= 38.63\,N$

5. Blocks *A* and *B* of weights 200 N and 150 N, respectively, are connected by a rope, which passes over a light frictionless pulley, as shown. The horizontal surface is rough. The coefficients of static and kinetic friction are 0.40 and 0.20, respectively. External forces *P* and *Q* act on block *B*, as shown. In Figure, force *P* equals 60 N. What is the maximum value of force *Q*, for which the system remains at rest? (In your solution, you must draw the free body diagrams.)







(3) $\sum_y F = 0$

$N - P - W_B = 0$

$N = 60 + 150 = 210\ N$

(2) $F_s = \mu_s N = 0{,}4 \times 210 = 84\ N$

(3) $\sum_x F = 0$

$-Q + T + F_s = 0$

(3) $\sum_y F = 0$

$T - W_A = 0$

$T = W_A = 200\ N$

$Q = T + F_s = 200 + 84 = 284\ N$ (1)