Name (PRINT): Exam 1 Solution

Seat Assignment: ZEC_____ : _____

Specify your **EXAM ID** on the right. Use 000 if you do not know your exam ID.

Circle your LAB SECTION

	ZEC 377	ZEC 371
9:50 am	**B377 McKensie**	**B371 Graham**
11:30 am	**C377 McKensie**	**C371 Tyler**
1:10 pm	**D377 Tyler**	**D371 Graham**

0 ◌	0 ◌	0 ◌
1 ◌	1 ◌	1 ◌
2 ◌	2 ◌	2 ◌
3 ◌	3 ◌	3 ◌
4 ◌	4 ◌	4 ◌
5 ◌	5 ◌	5 ◌
6 ◌	6 ◌	6 ◌
7 ◌	7 ◌	7 ◌
8 ◌	8 ◌	8 ◌
9 ◌	9 ◌	9 ◌

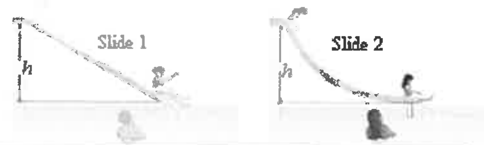
Instructions

- Sit in your assigned seat.
- Do not open the exam until instructed to do so.
- **Completely color in the dot for your chosen answers on multiple choice.**
- When time is called, immediately stop writing, close your exam booklet, remain seated, and TAs will be around to pick up the exam.
- Working after time is called results in an automatic deduction.
- Turn your equation sheets at the **end of the computer portion** of the exam.
- You will have 50 minutes for the written portion of the exam.

Guidelines

- **Assume 3 significant figures** for all given numbers unless otherwise stated
- **Show all of your work – no work, no credit**
- Write your final answer in the box provided
- Include units for all answers and directions for all vectors

1. (2 pts) Both slides start at the same height above the water. Assuming negligible friction, how does the speed (v_1) of swimmer 1 compare with the speed of swimmer 2 (v_2) at the bottom of the slide?



$V_1 = V_2$	$V_1 > V_2$	$V_1 < V_2$	Can't tell without the mass of each swimmer
●	○	○	○

2. (2 pts) A 3.0 kg ball is dropped from a height of 2.0 m. What is the approximate kinetic energy of the ball just before it hits the ground?

0 J	25J	50 J	60 J
○	○	○	●

$K_f = m\cdot g\cdot h$
$= 3\,kg\,(\sim 10\,\frac{m}{s^2})(2\,m)$
$= 60\,J$

3. (2 pts) The work done by the normal force on the roller coaster as it goes over the hill is: $W = \vec{F}\cdot\vec{r}$

$\vec{F}_N \perp \vec{r}$

positive	negative	zero	can't determine
○	○	●	○

4. (2 pts) A spring loaded gun shoots a ball with a speed of 1.0 m/s. If the spring is compressed 3 times as far, the speed of the ball will be:

1.0 m/s	3.0 m/s	9.0 m/s
○	●	○

$\frac{1}{2}kx_1^2 = \frac{1}{2}mv_1^2$
$\frac{1}{2}k(3x_1)^2 = \frac{1}{2}mv_2^2$
$\frac{V_2}{V_1} = \frac{3\cancel{x_1}}{\cancel{x_1}} = 3$ so $V_2 = V_1 \cdot 3$

5. (2 pts) The force required to compress a spring with a stiffness of 20 lb/inch 0.4 inches is:

1.6 lb	3.2 lb	4.0 lb	8.0 lb
○	○	○	●

$F_S = kx$
$= 20\,\frac{lb}{\cancel{in}}(0.4\,\cancel{in})$
$= 8\,lb$

6. (2 pts) The area under the curve for a force-distance graph gives:

Change in Kinetic Energy	Change in Momentum	Change in Velocity
●	○	○

7. (2 pts) In MATLAB, the text entered after a prompt generated by the `input` function

Is evaluated as code	Is returned as literal text	depends on other arguments passed to `input`
○	○	●

8. (2 pts) In MATLAB, when accessing rows and columns from a data table, we generally

Use indexing	Use dot notation	Use indexing for rows, dot notations for columns	Use dot notation for rows, indexing for columns
●	○	●	○
1 pt		2 pts	

9. (4 pts) **Output:** Let the following matrices be defined in the MATLAB workspace as: `A = [2,3]`, `B = [2,-3]`, and `C = [4,-1;3,-2]`, and let `var = 2`. What will be the output of the following; if the code will produce an error, write ERROR. **Assume that each problem is done independently from the others.**

1) `res1 = A * B`

[2,3] * [2,-3]

error

2) `res2 = size(B)`

res 2 = [1, 2]

[r, c] => 1 row, 2 column

3) `res3 = C(var,:)`

res 3 = C(2,:) % row2, all columns

so = [3, -2]

4) `res4 = A + var*B`

res4 = [2,3] + 2*[2,-3]

= [2,3] + [4,-6]

= [6, -3]

10. (6 pts) **Debugging:** Look through the script for mistakes that would cause the results of the following script to be unsatisfactory. There are a total of 3 lines of code in the script that contain mistakes. In the table provided below the script, specify the line number with the mistake and re-write the line of code beside it, correcting all errors discovered.

```
1   %% Example Problem
2   % display the calculated properties of a cylinder from data provided by the
3   user
4
5   clear % clears out workspace variables
6   clc % dry eraser of command window
7
8   %% Inputs
9   r = 4; % [cm], radius of cylinder
10  H = input('Enter the height [cm]: '); % prompt the user for a number
11  material = input('Enter the material: '); % prompt user for a name (text)
12
13  %% Calculations
14  V = pi*r^2*h; % calculate volume [cm^3]
15
16  %% Formatted Output
17  fprintf('A cylinder made of %s has a volume of %#.3g [cm^3]. \n', material, V)
18  fprintf('\tRadius = %0.2f [cm]\n', r)
19  fprintf('\tHeight = %s [cm]\n', H)
```

Line #	Corrected Code
11	material = input(... , 's');
14	V = pi * r^2 * H ;
19	fprintf('... = %0.2f ...', H)

11. (6 pts) A force of $(16\hat{\imath} - 7\hat{\jmath})lb$ acts through a displacement of $(4\hat{\imath} + 7\hat{\jmath})ft$. Determine the net work done by the force.

$\boxed{15 \text{ ft-lb}}$

$W = \vec{F} \cdot \vec{S}$

$= (16\hat{\imath} - 7\hat{\jmath})\text{ lb} \cdot (4\hat{\imath} + 7\hat{\jmath})\text{ ft}$

$= (16 \cdot 4)\,\cancel{\hat{\imath}\cdot\hat{\imath}}^{\,1} + (16 \cdot 7)\,\cancel{\hat{\imath}\cdot\hat{\jmath}}^{\,0} + (-7 \cdot 4)\,\cancel{\hat{\jmath}\cdot\hat{\imath}}^{\,0} + (-7 \cdot 7)\,\cancel{\hat{\jmath}\cdot\hat{\jmath}}^{\,1}$

$= (16 \cdot 4) + (-7 \cdot 7)$ ft-lb

$= (64 - 49)$ ft-lb

$= \boxed{15 \text{ ft-lb}}$

12. (8 pts) How much useful work can a 55% efficient 2400 Watt motor do in 4 minutes?

$\boxed{317000 \text{ J or } 317 \text{ kJ}}$

$W_{out} = ?$

$\eta = 55\% = 0.55$

$P_{in} = 2400 \text{ W}$

$t = 4 \text{ min} \left| \frac{60 \text{ sec}}{1 \text{ min}} \right. = 240 \text{ s}$

$\eta = \frac{P_{out}}{P_{in}}$

$P_{out} = \eta \cdot P_{in} = 0.55(2400 \text{ W}) = 1320 \text{ W}$

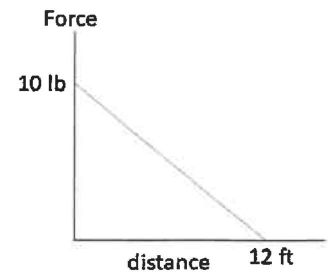
$P = \frac{E}{t} = \frac{W}{t}$, so $W = P \cdot t$

$W_{out} = 1320 \text{ W}(240 \text{ s}) = 316800 \text{ J}$

$\text{W} \downarrow \frac{\text{J}}{\text{s}}$

$= \boxed{317000 \text{ J}}$

13. (8 pts) A 0.25 slug object is subject to the force shown in the graph. If it starts at rest, how fast is the object moving after it has gone 12 ft?



$\boxed{21.9 \text{ ft/s}}$

$m = 0.25$ slug

$V_i = 0$ ft/s

$d = 12$ ft

F = variable, from graph

$V_f = ?$ ft/s

$W = F \cdot d \Rightarrow$ area under the curve

$W = \frac{1}{2} b \cdot h = \frac{1}{2}(12 \text{ ft})(10 \text{ lb})$

$= 60$ ft-lb

$W = \Delta KE$ so $W = \frac{1}{2} m v_f^2 - \cancel{\frac{1}{2} m v_i^2}^{\,0}$

so: $\cancel{\frac{2}{1}}\cancel{\frac{1}{2}} m v_f^2 = 60 \text{ ft-lb} \cdot \frac{2}{1}$

$\sqrt{\frac{\cancel{m} v_f^2}{\cancel{m}}} = \sqrt{\frac{120 \text{ ft-lb}}{m}}$

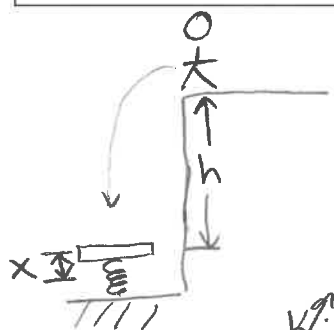
$v_f = \sqrt{\frac{120 \text{ ft} \cdot \text{lb}}{0.25 \text{ slug}}}$

$= 21.9089$ ft/s

$= \boxed{21.9 \text{ ft/s}}$

14. (12 pts) Athena wants to figure out the spring constant of a spring she found in Zeanah. She places the spring on the ground and attaches a level platform to the top. Then she climbs a ladder so she is standing 0.78 m above the platform. She steps off and falls to the platform. It compresses 18.4 cm after she hits it. Assuming she has a mass of 56 kg and the mass of the spring and platform are negligible, what is the spring constant? (MUST show entire COE equation indicating all energy forms not included.)

$$\boxed{31300 \ \frac{N}{m}}$$



$h = 0.78 m$

$x = 18.4 \text{ cm} \left| \frac{1 m}{100 \text{ cm}} \right. = 0.184 m$

$m = 56 kg$

$$\cancel{K_i}^{0} + U_{g_i} + \cancel{U_{e_i}}^{0} + \cancel{W_{in}}^{0} = \cancel{K_f}^{0} + \cancel{U_{g_f}}^{0} + U_{e_f} + \cancel{E_{loss}}^{0}$$

$U_{g_i} = U_{e_f}$ where:

$U_{g_i} = m_A \cdot g \cdot (h + x)$

$U_{e_f} = \frac{1}{2} k x^2$

$$\frac{\frac{2}{1} \cdot m_A g (h+x)}{x^2} = \frac{\cancel{\frac{1}{2}} k x^2 \cdot \frac{2}{1}}{x^2}$$

$$k = \frac{2 m_A g (h+x)}{x^2}$$

$$= \frac{2(56 kg)(9.81 \frac{m}{s^2})\overbrace{(0.78 + 0.184)}^{\Rightarrow 0.964 m} m}{\underbrace{(0.184)^2}_{\Rightarrow 0.033856}}$$

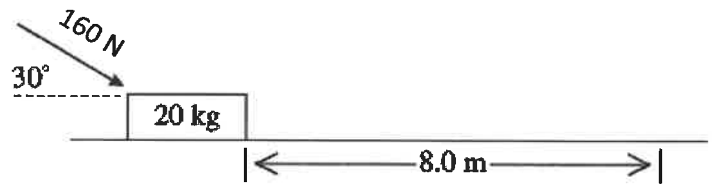
$$= 31284.4 \ \frac{N}{m}$$

$$= \boxed{31300 \ \frac{N}{m}}$$

Don't forget to turn the page for the last problem.

15. (12 pts) Dr. Maczka pushes a 20 kg box across a rough horizontal surface with a force of 160 N. He pushes the box a distance of 8.0 m, and over this distance the speed changes from 0.7 m/s to 4.20 m/s. How much energy is lost to friction during this process? (MUST show entire COE equation indicating all energy forms not included.)

937 J



$m_{box} = 20\ kg$

$P = 160\ N$ @ $30°$

$d = 8.0 m$

$v_i = 0.7\ m/s$

$v_f = 4.2\ m/s$

$$K_i + \cancel{U_{g_i}}^{0} + \cancel{U_{e_i}}^{0} + W_{in} = K_f + \cancel{U_{g_f}}^{0} + \cancel{U_{e_f}}^{0} + E_{loss}$$

$$K_i + W_{in} = K_f + E_{loss}$$

$$K_i = \frac{1}{2} m v_i^2 = \frac{1}{2}(20kg)(0.7\tfrac{m}{s})^2 = 4.9\ J$$

$$K_f = \frac{1}{2} m v_f^2 = \frac{1}{2}(20kg)(4.2\tfrac{m}{s})^2 = 176.4\ J$$

$$W_{in} = P\cos(30)\cdot d = 160\ N \cos(30)\cdot 8\ m = 1108.5\ J$$

$$E_{loss} = K_i + W_{in} - K_f = \frac{1}{2} m (v_i^2 - v_f)^2 + P\cos(30) d$$

$$= 4.9\ J + 1108.5\ J - 176.4\ J$$

$$= 937.013\ J$$

$$= \boxed{937\ J}$$