

**Mechanics Mock Test**  
**IJSO Theory Mock Test**  
**Answer Sheet**

**Problem 1 – Theme Park (15.00 points)**

**Part A – Getting to the Theme Park (1.00 points)**

A1. What is the average velocity the tourist calculated, in km/h?

(0.20 points)

**Calculation:**

$v =$



A2. Using this new information, find the new average velocity of the plane

(0.50 points)

**Calculation:**

$v =$

A3. Which of the given graphs most accurately resembles the portion of the graph which shows the plane going from the time zone GMT+5 to the time zone GMT+6?

(0.30 points)

Answer :

(0.30 points)



**Part B – Bungee Jumping (4.00 points)**

B1. Find the values of  $x$  and  $\theta$ .

(1.00 points)

**Calculation:**



$x =$

$\theta =$

B2. Find the velocity of the man at the described moment.

(0.50 points)

**Calculation:**

$v =$

B3. Find the final velocity.

(0.50 points)

**Calculation:**



$v_f =$

B4. Find the maximum tension in the code.

(1.00 points)

**Calculation:**



T =

B5. Find the maximum extension of the code.

(1.00 points)

**Calculation:**



$\Delta L =$

**Part C – Water Slide (4.00 points)**

C1. Find the speed  $v_{\text{launch}}$  of the boat.

(0.50 points)

**Calculation:**



$v_i =$

C2. Find the horizontal distance (range) R.

(0.75 points)

**Calculation:**



R =

C3. Find the time of flight  $t$  and the vertical component of velocity on impact  $v_{y,\text{impact}}$ .

(0.50 points)

**Calculation:**

$t =$

$v_{y,\text{impact}} =$



C4. The pool is designed to begin 6.0 m horizontally from the ramp edge and extends for 6.0 m. Does the boat land in the pool?

(0.25 points)

**Calculation:**

C5. Find the range the boat can be compressed such that it still manages to land inside the pool

(2.00 points)

**Calculation:**





Range:  $\leq x \leq$

**Part D – Go-Karting (2.00 points)**

D1. Calculate the maximum deceleration of the kart

(0.50 points)

**Calculation:**

$a_{\max} =$

D2. Calculate the braking force the driver needs to apply in order to achieve the maximum deceleration.

(1.00 points)

**Calculation:**

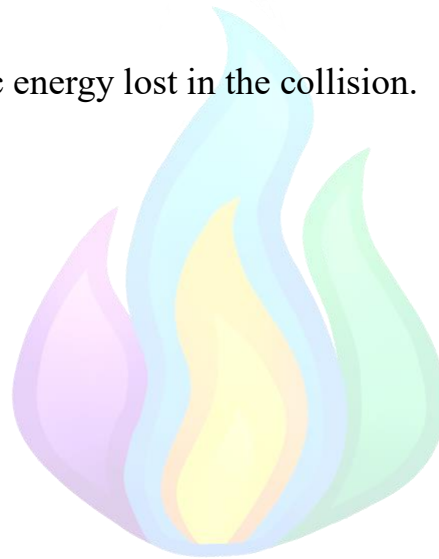


$$F_{\text{pedal}} =$$

D3. Determine the kinetic energy lost in the collision.

(0.50 points)

**Calculation:**



Energy lost =

**Part E – Skateboarding (4.00 points)**

E1. For an arbitrary natural number  $k$ , find the value of  $\Delta H = H_k - H_{k+1}$

(0.80 points)

**Calculation:**



$\Delta H =$

E2. How many times does the skater go up a ramp before he finally stops?

(0.70 points)

**Calculation:**

No. of times the skater goes up:

E3. After the skater stops, where does he stop?

(0.70 points)

**Calculation:**

The skater stops \_\_\_\_\_ along the flat plane.

E4. In which of the following cases does the result in E1 increase?

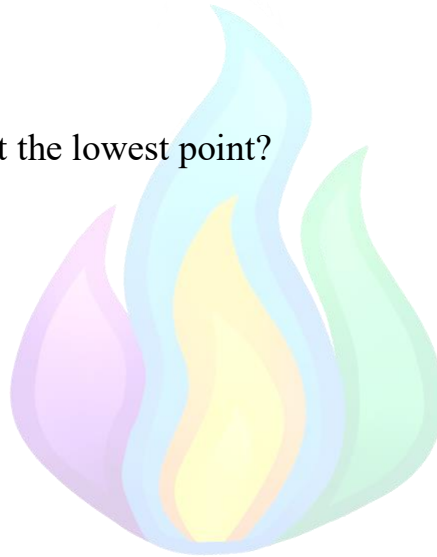
(0.35 points)

- Skater weighs  $M = 100\text{kg}$
- Skater weighs  $M = 70\text{kg}$
- Skate park is on the Moon ( $g = 1.62 \frac{\text{m}}{\text{s}^2}$ )
- Skate park is on Jupiter ( $g = 26.0 \frac{\text{m}}{\text{s}^2}$ )
- Flat portion gets longer
- Flat portion gets shorter
- Friction on the inclines is not negligible

E5. What is his velocity at the lowest point?

(0.50 points)

**Calculation:**



$v =$

E6. With what normal force is he acting on the track at the lowest point?

(0.65 points)

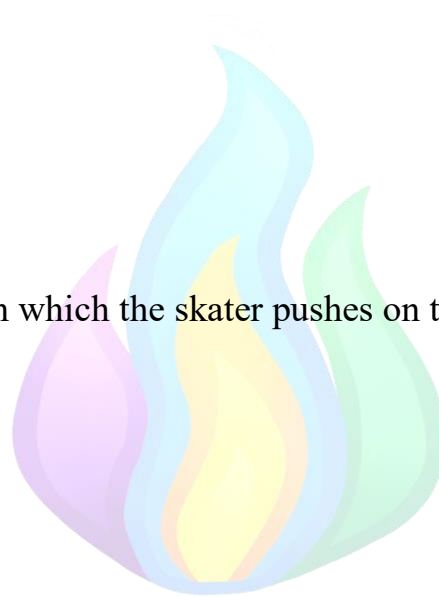
**Calculation:**

N =

E7. Find the pressure with which the skater pushes on the track at the lowest point.

(0.30 points)

**Calculation:**



P =

**Extra Space for Problem 1:**



**Problem 2 – Mechanics of Atoms and Molecules (7.00 points)**

**Part A – The Bohr model of the Atom (1.60 points)**

A1. Calculate the Bohr radius. Express it in angstroms ( $1\text{\AA} = 10^{-10}\text{m}$ )

(0.30 points)

**Calculation:**

$a_0 =$

A2. Under this assumption, find the period of the orbit.

(0.80 points)

**Calculation:**

T =

A3. Using this new assumption, what is the period of the electron?

(0.50 points)

**Calculation:**

T =

**Part B – Rutherford’s Experiment (1.50 points)**

B1. What is the number density of gold atoms in a monoatomic gold layer

(0.50 points)

**Calculation:**

Atom Density =

B2. What is the mass surface density ( $\text{mg}/\text{m}^2$ ) of monoatomic gold?

(0.50 points)

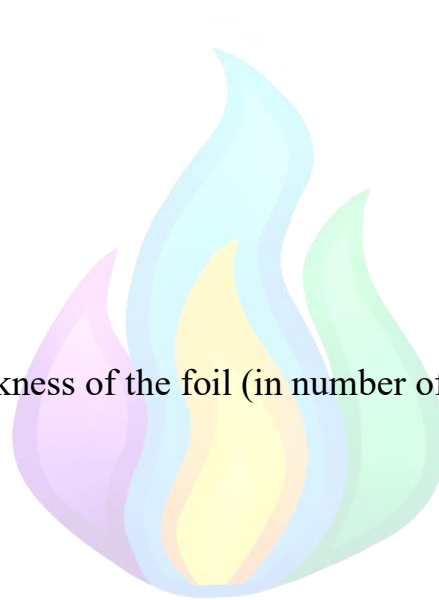
**Calculation:**

Mass density =

B3. Find the average thickness of the foil (in number of layers).

(0.50 points)

**Calculation:**



Number of layers =

**Part C – Nuclear Density (2.20 points)**

C1. Which of the following graphs would you expect to be a linear graph?

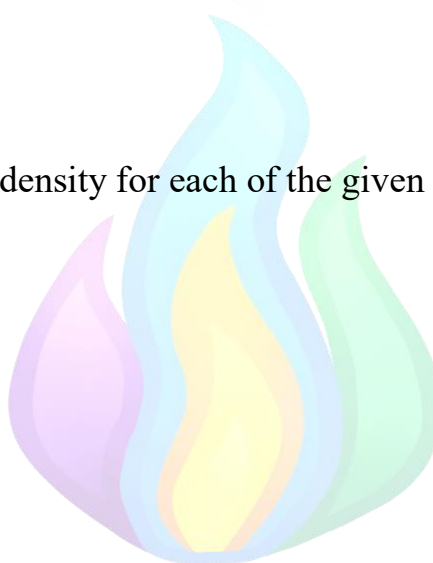
(0.25 points)

- A in terms of  $r^3$
- A in terms of  $r^2$
- A in terms of  $r^1$
- A in terms of  $r^{-1}$
- A in terms of  $r^{-2}$
- A in terms of  $r^{-3}$

C2. Calculate the nuclear density for each of the given elements

(0.75 points)

**Calculation:**



C3. Calculate the mean value, the 4 errors and the mean error.

(0.75 points)

**Calculation:**



C4. Calculate the value of the percent error.

(0.25 points)

**Calculation:**

C5. Based on your result in C4, is the hypothesis correct?

- Yes
- No

(0.20 points)

**Part D – A look at the Simplest Molecules (1.70 points)**

D1. Find the stiffness  $k$  of the bond.

(0.50 points)

**Calculation:**

$k =$

D2. Find the frequency of its oscillations.

(0.70 points)

**Calculation:**

$f =$

D3. Find the maximum bond length  $r_{\max}$  and the minimum  $r_{\min}$

(0.30 points)

**Calculation:**

$r_{\max} =$

$r_{\min} =$



D4. If the oscillation energy of the hydrogen molecule is lowered and the amplitude of the oscillations decreases from 17% to 5%, what will happen to the frequency?

- It will get lower
- It will stay the same
- It will get higher

(0.20 points)

**Extra Space for Problem 2:**



**Problem 3 – A Simple Experiment (4.00 points)**

**Part A – Finding the Length of this Rope (2.20 points)**

A1. Note the approximate moment at which the phone was released and the moment at which it was caught again to check the obtained data.

(0.30 points)

**Calculation:**



A2. In which of the position is the acceleration maximum?

(0.25 points)

**Calculation:**

A3. How many times does the phone pass through B during an entire period?

(0.20 points)

**Calculation:**

A4. Using the data in the graph, estimate the period of the studied pendulum.

(0.75 points)

**Calculation:**

A5. Knowing the gravitational acceleration  $g = 9.81 \frac{\text{m}}{\text{s}^2}$ , find the length of the rope.

(0.75 points)

**Calculation:**



l =

A6. Why does the average acceleration overall decrease in time?

- Due to inaccuracies in the sensor of the phone
- Due to air friction and similar dissipative forces
- That is the normal behavior of an ideal gravitational pendulum

(0.25 points)

**Part B – Elasticity of the Rope (1.80 points)**

B1. Identify the moment at which the phone was launched upwards.

(0.15 points)

**Calculation:**

B2. Find the stiffness  $K$  of the spring.

(0.75 points)

**Calculation:**



$k =$

B3. Find the relative elongation of the rope at that moment (the percent by which the rope gets longer)

(0.75 points)

**Calculation:**

Relative elongation =



B4. According to your result in part B3, is neglecting elasticity in part A reasonable?

(0.15 points)

**Calculation:**

**Extra Space for Problem 3:**



**Problem 4 – Meeting on the Vertical (4.00 points)**

**Part A – The Meeting (2.00 points)**

A1. Determine the time  $t$  after launch at which the stones will meet.

(0.75 points)

**Calculation:**



$t = 2 \text{ s}$

A2. At what height  $h$  (measured from the ground) will this happen?

(0.50 points)

**Calculation:**

$h =$

A3. What condition must the initial speed  $v_0$  satisfy for a collision to occur at all?

(0.75 points)

**Calculation:**



Condition :

**Part B – The Collision (2.00 points)**

B1. Find the velocity of the stones after the collision. Is it directed upwards or downwards?

(0.50 points)

**Calculation:**



$v_f =$

Direction :

B2. Find the maximum height that stone A reaches after it rebounds.

(1.00 points)

**Calculation:**

s =



B3. Find the impulse (J or  $\Delta p$ ) stone A exerts on stone B during the collision.

(0.50 points)

**Calculation:**

J =  $\Delta p$  =

**Extra Space for Problem 4:**

