

Addis Ababa University College of Natural and Computational Sciences

Department of Physics

Phys 1011 Mid-Semester Examination

Date: 13/08/2021

Time: 1:20 hrs

General Instruction:

Attempt all questions: Write your answers as neatly as possible

Name: _____ Sec. _____ ID. No. _____

Part-I: Choose the best answer from the multiple choices given. (15 pts.)

1. Which of the following statement is not correct about Calibration?
 - A. Checking the scale of the instrument against an accepted standard to ensure accuracy of readings.
 - B. Response of the instrument to a unit change of input**
 - C. Divide the scale into appropriate number of intervals/graduation marks
 - D. Fix or set the scale to ensure accuracy of absolute values.

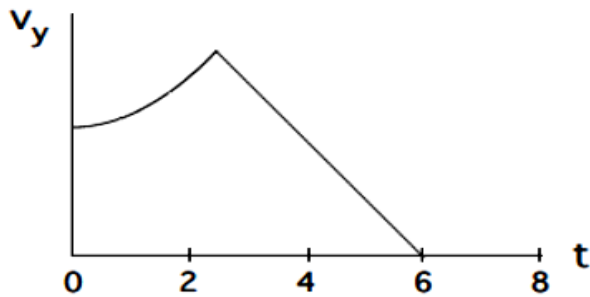
2. A person standing at the edge of a cliff throws one ball straight up and another identical ball straight down, each at the same initial speed. Neglecting air resistance, which ball hits the ground below the cliff with the greater speed:
 - A. Ball initially thrown upward;
 - C. Neither; they both hit at the same speed.**
 - B. Ball initially thrown downward;
 - D. Difficult to estimate

3. What is the ball's velocity at point Y?



- A. Equal to its horizontal velocity.**
- C. Half its initial velocity.
- B. Twice its initial velocity.
- D. Zero.

4. The following graph represents the y-component of the velocity of an object as a function of time. Which of the following could be a reasonable description of its motion? The object accelerates upward

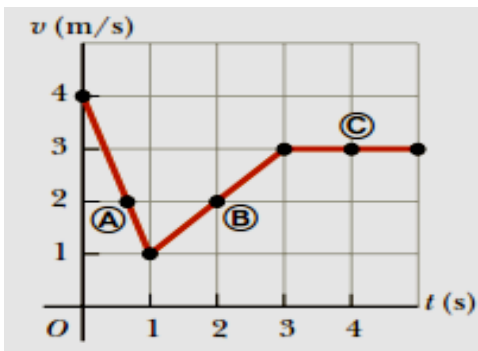


- A. at a constant rate and then accelerates downward until it hits the ground at $t = 6$ s.
- B. at a constant rate and then accelerates downward until it reaches its highest point at $t = 6$ s.
- C. at a non-constant rate and then accelerates downward until it hits the ground at $t = 6$ s.
- D. at a non-constant rate and then accelerates downward until it reaches its highest point at $t = 6$ s.
5. Which of the following statement is not true about uniform circular motion?
- A. The centripetal acceleration is constant throughout the motion.
- B. Tangential acceleration is responsible for the change of the speed.
- C. Radial acceleration is responsible for the change of the direction of the tangential velocity.
- D. Radial acceleration is responsible for the change of the direction of the radial velocity.
6. A crate is sitting in the center of a flatbed truck. As the truck accelerates to the east, the crate moves with it, and doesn't slide on the bed of the truck. In what direction is the friction force exerted by the bed of the truck on the crate?
- A. To the west
- B. To the east
- C. There is no friction force because the crate isn't sliding
- D. Difficult to estimate
7. Which of the following is true about action and reaction forces?
- A. Action and reaction forces always act on a single body.
- B. A body experiences no net force because of action and reaction forces.
- C. Action and reaction forces exist together.
- D. Action and reaction forces have different line of action.

8. A body of mass m is suspended from a spring balance attached to the ceiling of an elevator. If the elevator is accelerating downward, the reading of the balance will be
- A. Greater than the weight of the body on the ground.
 - B. Equal to the weight of the body on the ground.
 - C. Equal to the net force on the body.
 - D. Less than the weight of the body on the ground.
9. The acceleration due to gravity varies over the Earth's surface due to_____.
- A. Altitude
 - B. Local geology
 - C. The shape of the earth
 - D. All
10. If the net work done on a particle is zero, which of the following statements must be true?
- A. The velocity is zero
 - B. The velocity is decreased
 - C. The velocity is unchanged
 - D. The speed is unchanged

Part-II: Give short answers to the following questions (9 pts.)

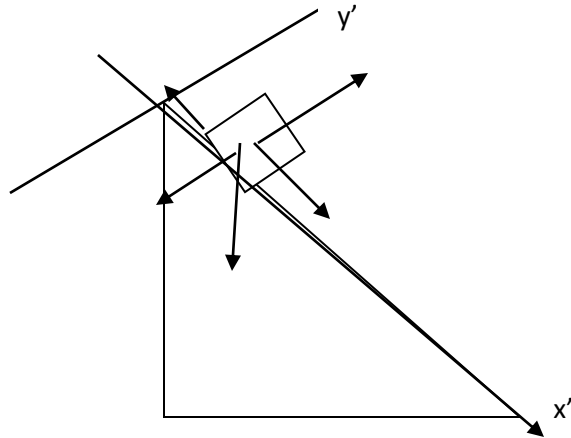
1. **Precision** refers to how close the measured values are to each other.
2. A projectile, fired with unknown initial velocity, lands 20 s later on the side of a hill, 3000 m away horizontally and 450 m vertically above its starting point. The vertical and horizontal components of its initial velocities are **122.5 m/s and 150 m/s** respectively.
3. A car travels around a curve which has a radius of 410 m. The curve is flat, not banked, and the coefficient of static friction between the tires and the road is 0.78. At what speed can the car travel around the curve without skidding? **56.55 m/s or 55.98 m/s** (based on the value of g).
4. A baseball player moves in a straight-line path in order to catch a fly ball hit to the outfield. His velocity as a function of time (see the figure below). The instantaneous acceleration at points **Ⓐ -3 m/s² Ⓑ 1 m/s² and Ⓒ 0 m/s²**



5. A pendulum of length L with a bob of mass M is pulled aside until the bob is a distance $L/4$ above its equilibrium position the bob is then released. What is the speed of the bob as it passes half of its equilibrium position? $\sqrt{gl/2}$ (with 2 outside)
6. If the mass of one of the two bodies is doubled and the distance between them is doubled, the gravitational force between them is halved

Part-III: Work out the following problems on the space below them. Make sure you show all the necessary steps

1. A cube slides down a rough inclined plane of inclination θ with constant velocity. If this cube is projected up the plane with a velocity, V_o , then at what distance along the inclined plane, the cube will come to rest? **(4 pts.)**



When the cube is sliding down, (2pt)

$a=0$ because the cube is moving at constant velocity

Newton's second law of Motion

$$\text{Along } y' \quad N - mg\cos\theta = ma_{y'} = 0$$

$$N = mg\cos\theta \dots \text{eq 1}$$

$$\text{Along } x' \quad -f + mg\sin\theta = ma_{x'}$$

$$f = mg\sin\theta = \mu_k N \dots 2$$

substituting eq 1 into 2 :

$$f = \mu_k mg\cos\theta = mg\sin\theta \dots (3)$$

$$\mu_k = \tan \theta \dots (4)$$

When projected up (2pt)

$$\text{Along } x' \quad -f - mg\sin\theta = ma_{x'} \dots (5)$$

Substituting eqn (3, and 4) into (5)

$$-mg\sin\theta - mg\sin\theta = ma_{x'}$$

$$a_{x'} = -2g\sin\theta \dots (6)$$

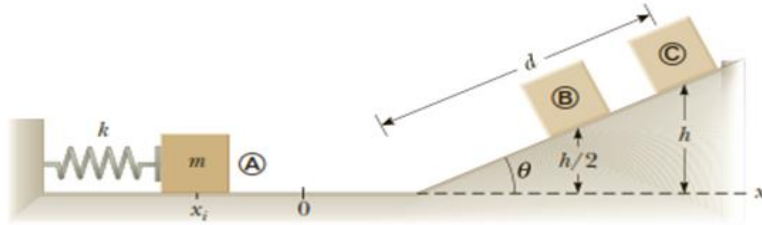
$$\text{but } V_f^2 - V_o^2 = 2 a S \dots (7)$$

Since the block comes to rest ($v_f = 0$), substituting (6) to (7)

$$S = V_o^2 / 4g\sin\theta$$

2. A 0.250kg block rests on a horizontal, frictionless surface as in the figure below. The block is pressed back against a spring having a constant of $k= 525 \text{ N/m}$, compressing the spring by 10 cm to point (A). Then the block is released.

- A. Find the maximum distance d the block travels up the frictionless incline if $\theta = 30.0^\circ$.
 B. How fast is the block going at half its maximum height?
 C. Repet (a) and (b) if there is 0.20 coefficient of friction in the inclined surface. (7 pts)



a) Givens: $\theta = 30^\circ$, $V_f = V_o = 0$ since the block is released at the beginning and will come to rest (2pt)

$m = 0.250 \text{ kg}$, $k = 525 \text{ N/m}$ Compression distance (x) = 0.1 m , Friction Force = 0, $h_o = 0$

$$W_{net} = W_g + W_{fr} + W_N = \Delta KE, \dots\dots(1)$$

where g , fr and N are gravitational, restoring and normal forces respectively

But $W_N = 0$ since the N is perpendicular to the path

Eq 1 becomes

$$\Delta KE + \Delta PE_{el} + \Delta PE_g = 0 = \frac{1}{2} m(V_f^2 - V_o^2) + \frac{1}{2} k(x_f^2 - x_o^2) + mg(h_f - h_o) \dots\dots(2)$$

Substituting the givens in eq 2

$$\frac{1}{2} m(V_f^2 - V_o^2) + \frac{1}{2} k(x_f^2 - x_o^2) + mg(h_{max} - h_o) = 0$$

$$mgh_f = \frac{1}{2} k x_o^2$$

$$h_{max} = \frac{k x_o^2}{2 mg} \dots\dots(3)$$

But the distance the block will travel $d = h_f / \sin \theta$

From eqn (3)

$$d = \frac{1}{\sin \theta} \frac{kx_o^2}{2mg} = \frac{525 \text{ N/m} \times (0.1 \text{ m})^2}{2 \times 0,250 \text{ kg} \times 9,8 \text{ m/s}^2 \sin 30}$$

$$= 2,14 \text{ m}$$

b) Find the velocity (vf) when (2pt)

$$h = \frac{h_{max}}{2}$$

From eqn (2):

$$\frac{1}{2} m (V_f^2 - V_o^2) + \frac{1}{2} k (x_f^2 - x_o^2) + mg (h_{max}/2 - h_o) = 0$$

Substituting the givens i.e $V_o = x_f = h_o = 0$

$$\frac{1}{2} m V_f^2 - \frac{1}{2} k x_o^2 + mg \frac{h_{max}}{2} = 0$$

Rearranging,

$$V_f^2 = \frac{kX_o^2}{m} - gh_{max}$$

$$h_{max} = \frac{kx_o^2}{2mg}$$

Substituting for

$$V_f = \sqrt{\frac{kX_o^2}{2m}} = \sqrt{\frac{525 \text{ N/m} \times (0.1 \text{ m})^2}{2 \times 0,250 \text{ kg}}} = 3,24 \text{ m/s}$$

c) In c the surface has friction Equation becomes (3pt)

$$W_{net} = W_g + W_{f_r} + W_N + W_{friction} = \Delta KE, \dots\dots(4)$$

$$\Delta KE + \Delta PE_{el} + \Delta PE_g = -f_r \times d$$

But the $f_r = \mu_k N$

On the inclined plane

$$\sum F'_y = N - mg \cos \theta = 0, \text{ where } y' \text{ is the axis perpendicular to the plane}$$

$$\text{Hence, } N = mg \cos \theta \text{ and } f_r = \mu_k mg \cos \theta$$

Equation 4 becomes

$$\Delta KE + \Delta PE_{el} + \Delta PE_g = -\mu_k mg \cos \theta \times d \dots 5$$

Substituting the givens 5 becomes

$$mgh_{max} - 1/2 k x_o^2 = -\mu_k mg \cos \theta \times d$$

$$\text{But } d \sin \theta = h_{max}$$

$$mgd \sin \theta - 1/2 k x_o^2 = -\mu_k mg \cos \theta \times d$$

$$d = \frac{1/2 k x_o^2}{mg \sin \theta + \mu_k mg \cos \theta}$$

=

$$\frac{\frac{1}{2} \times 525 \text{ N/m} \times (0,1 \text{ m})^2}{0,250 \text{ kg} \times 9,8 \text{ m/s}^2 (\sin 30 + 0,2 \times \cos 30)} = 1,59 \text{ m}$$

Find the velocity at half maximum height

$$h = \frac{h_{max}}{2}$$

- b) Find the velocity (v_f) when
- From eqn (2):

$$\frac{1}{2} m(V_f^2 - V_o^2) + \frac{1}{2} k(x_f^2 - x_o^2) + mg(h_{max}/2 - h_o) = -\mu_k mg \cos\theta \times d_2$$

- Substituting the givens i.e $V_o = x_f = h_o = 0$ and

$$d_2 = \frac{h_{max}}{2 \sin\theta}$$

$$\frac{1}{2} m(V_f^2) - \frac{1}{2} k x_o^2 + mgh_{max}/2 = -\mu_k mg \cos\theta \times \frac{h_{max}}{2 \sin\theta}$$

$$V_f^2 = k/m x_o^2 - gh_{max} - \mu_k g \cos\theta \times \frac{h_{max}}{\sin\theta}$$

$$V_f$$

$$= \sqrt{\frac{k}{m} x_o^2 - g h_{max} - \mu_k g \cos \theta \times \frac{h_{max}}{\sin \theta}}$$

=

$$\sqrt{\frac{525 \text{ N/m} \times (0,1 \text{ m})^2}{0,250 \text{ kg}} - 9,8 \frac{\text{m}}{\text{s}^2} \times 1,59 \text{ m} - 0,2 \times 9,8 \frac{\text{m}}{\text{s}^2} \times \frac{1,59 \text{ m}}{\tan 30}}$$

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Addis Ababa University College of Natural and Computational Sciences Department of Physics
Phys 1011 Mid-Semester Examination Answer sheet, Aug. 13, 2021

Name: _____ **Sec.** _____ **ID. No.** _____

Part I: Multiple Choice Questions (15 pts.)

No	Answer
1	
2	
3	

No	Answer
4	
5	
6	

No	Answer
7	
8	
9	

No	Answer
10	

Part II: Short Answer Questions (9 pts.)

No	Answer
1	
2	
3	
4	
5	
6	

