P115 – 2020 – Midterm Examination #2 – Alternative Version

Description

This set of 1 statement of commitment to academic integrity and 9 questions is the second midterm exam for PHYS 115 Fall 2020 at the University of Saskatchewan.

33% of the exam mark is based on the answers for the 6 multiple-choice questions submitted through WebAssign. All 6 questions are weighted equally.

67% of the exam mark is based on the answers (submitted through WebAssign) and solutions (submitted through Canvas) for the 3 word problems. All 3 word problems are weighted equally.

Instructions

Answers for **all** questions need to be submitted in WebAssign.

For each of questions 8 through 10, in addition to submitting your answers in WebAssign, write the complete solution, **including a diagram**, using the problem-solving method discussed in class.

Your solutions must use the same symbols as are used on the formulae sheet.

Formulas not on the Formulae Sheet must be derived.

Keep extra decimal places throughout your calculations, and then round-off your final answer to three significant figures.

Submit your answer to each question in WebAssign.

When you have finished the entire exam, scan your written work for questions 8 through 10 and submit a single multi-page PDF file using the link in the Canvas site for your section.

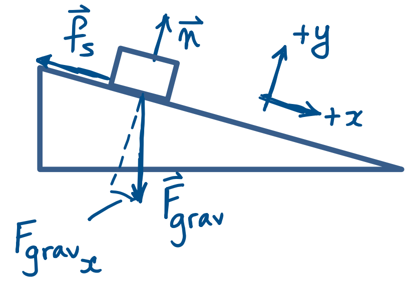
Your WebAssign submission is due no later than 90 minutes after the questions become available and your Canvas submission is due no later than 120 minutes after the questions become available. LATE SUBMISSIONS WILL NOT BE ACCEPTED.

1. - UofS-P115-P117-Honour [4820285]
On my honour, I pledge that I will not give or receive aid during this assessment. I understand that I am expected to complete this assessment with no communication with other persons and no resource material other than the PHYS 115/117 Formulae sheet. I recognize that it is my responsibility to uphold academic integrity and I agree to follow the rules of this assessment and the guidelines laid forth in the policies of the University of Saskatchewan. Furthermore, I fully understand that disciplinary action may be taken against me if I am discovered to have communicated with another person or to have used an internet resource.

- Yes, I understand and agree.

2. - MT-2-S-Alt-2 [4853406]
A crate remains stationary after it has been placed on a ramp inclined at an angle with the horizontal. Which one of the following statements **must** be true about the magnitude of the frictional force that acts on the crate?

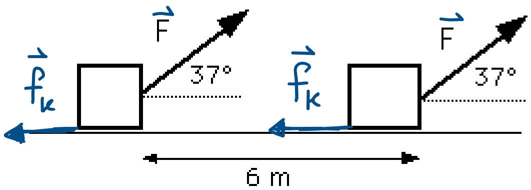
- It is larger than the weight of the crate.
- (key) It is equal to the component of the gravitational force acting down the ramp.
- It is greater than the component of the gravitational force acting down the ramp.
- It is equal to the product of the coefficient of static friction and the normal force of the ramp on the crate.
- It is at least equal to the weight of the crate.



stationary $\Rightarrow \sum \vec{F} = 0 \Rightarrow \sum F_x = 0$

$F_{grav_x} - f_s = 0 \Rightarrow f_s = F_{grav_x}$

3. - MT-2-B-Alt-3 [4853404]
A box is being pulled across the horizontal ground at a constant velocity by a force of magnitude *F* directed at 37° above the horizontal. There is a constant frictional force of 120 N acting on the box during a 6 meter displacement. What is the work done by the applied force in this displacement?



Work-Energy Theorem: $W_{net} = \Delta KE$

constant velocity $\Rightarrow \Delta KE = 0$

$\therefore W_F + W_{f_k} = 0 \Rightarrow W_F = -W_{f_k}$

$W_F = -f_k(\cos 180°)d$

- 580 J
- 430 J
- -720 J
- 960 J
- (key) 720 J

$W_F = -(120\text{N})(-1)(6\text{m}) = \boxed{+720\text{ J}}$

4. - MT-2-S-Alt-4 [4853398]
If the net work done on an object is zero, which one of the following statements **must** be true?

- The velocity of the object is unchanged.
- The velocity of the object is zero.
- The velocity of the object is decreased.
- (key) The speed of the object is unchanged.
- More information is needed.

Work-Energy Theorem:

$W_{net} = \Delta KE$

$0 = \Delta KE \Rightarrow KE_f = KE_i$

$\therefore$ speed must be constant

(The velocity can be changing. e.g. Circular motion at constant speed.)

5\. - MT-2-B-Alt-5 [4853403]
Two masses collide head-on (a one dimensional collision). A 2-kg mass initially moving at +10 m/s collides with a 4-kg mass initially moving at −5 m/s. After the collision, the 2-kg mass has a velocity of −8 m/s and the 4-kg mass has a velocity of +4 m/s. Which one of the following statements is true about this collision?

- Only kinetic energy is conserved.
- Newton's laws are violated (a one dimensional collision cannot occur).
- Neither linear momentum nor kinetic energy is conserved.
- Both linear momentum and kinetic energy are conserved.
- Only linear momentum is conserved.

Collision ⇒ momentum is conserved.

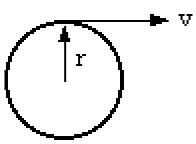
CHECK: $P_{tot_i} = (2\,kg)(+10\,m/s) + (4\,kg)(-5\,m/s) = 0$

$P_{tot_f} = (2\,kg)(-8\,m/s) + (4\,kg)(+4\,m/s) = 0.$

Note that $|v_{1f}| < |v_{1i}|$ and $|v_{2f}| < |v_{2i}|$ ⇒ $KE_{tot_f} < KE_{tot_i}$

∴ Kinetic energy is not conserved.

6\. - MT-2-B-Alt-6 [4853401]
A cable is being pulled off a drum of radius r = 0.25 m with a velocity v. At the instant shown, v is increasing at the rate of 2 m/s^2. What is the angular acceleration of the drum about its center at this instant?



$v = v_t$

$\alpha = \frac{a_t}{r}$; Given that $a_t = \frac{\Delta v_t}{\Delta t} = 2\,m/s^2$. ∴ $\alpha = \frac{2\,m/s^2}{0.25\,m}$

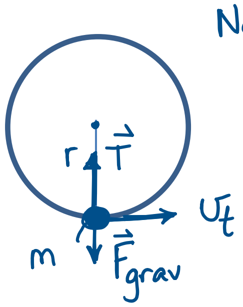
- 32 rad/s^2
- 0.50 rev/s^2
- 16 rad/s^2
- 8.0 rad/s^2
- 0.50 rad/s^2

$\alpha = 8\,rad/s^2$

7\. - MT-2-R-B-Alt-7 [4853396]
A stone of mass m is attached to a string and whirled in a vertical circle of radius r. At the exact bottom of the circular path the tension in the string is exactly equal in magnitude to 3 times the stone's weight. The stone's speed, v, at this point is given by which one of the following expressions?

- $v = \sqrt{2gr}$
- $v = \sqrt{gr}$
- $v = 4gr$
- $v = 2\sqrt{gr}$
- $v = 2gr$

Newton II for Circular Motion:



$\sum F_r = ma_c$

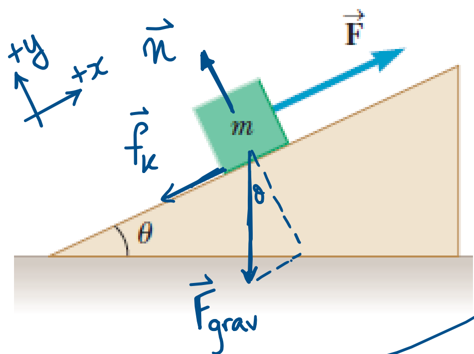
$+T - mg = \frac{mv^2}{r}$; Given $T = 3mg$

$3mg - mg = \frac{mv^2}{r}$ ⇒ $2gr = v^2$ ⇒ $v = \sqrt{2gr}$

$2mg = \frac{mv^2}{r}$ ⇒ $v = \sqrt{2gr}$

8. - MT-2-S-Alt-8 [4853399]

As shown in the following diagram, an object is being pulled up a ramp by a force **F**. The mass of the object is m = 5.71 kg, the angle of incline of the ramp is θ = 29.0°, and the force has a magnitude of F = 44.9 N and is parallel to the ramp. The coefficient of kinetic friction between the object and the ramp is 0.110. Calculate the magnitude of the object's acceleration (in m/s^2).



2.17 m/s^2

Apply Newton's 2nd Law:

$$\sum \vec{F} = m\vec{a}$$

$$\sum F_x = ma \quad \text{and} \quad \sum F_y = 0$$

$$F - f_k - F_{grav_x} = ma \; ; \quad +n - F_{grav_y} = 0$$

$$n = F_{grav_y} = mg\cos\theta$$

$$F - f_k - mg\sin\theta = ma$$

$$F - \mu_k n - mg\sin\theta = ma$$

$$F - \mu_k(mg\cos\theta) - mg\sin\theta = ma$$

$$a = \frac{F - \mu_k mg\cos\theta - mg\sin\theta}{m}$$

$$a = \frac{44.9\text{N} - (0.110)(5.71\text{ kg})(9.80\text{m/s}^2)(\cos 29.0°) - (5.71\text{ kg})(9.80\text{m/s}^2)(\sin 29.0°)}{5.71\text{ kg}}$$

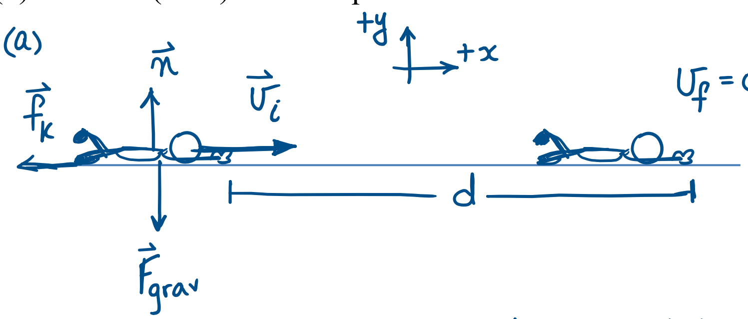
$$\boxed{a = 2.17\text{ m/s}^2}$$

9. - MT-2-S-Alt-9 [4853397]
A running person, with a mass of 78.0 kg, falls and slides along the horizontal ground. At the start of the slide, the person has a speed of 4.90 m/s. The coefficient of friction between the person and the ground is 0.692.

(a) Calculate the change in mechanical energy of the person (in J) from the start of the slide to when the person comes to rest. If the person loses mechanical energy include the minus sign with your numerical answer. -936 J

(b) How far (in m) does the person slide? 1.77 m

(a)



$\sum F_y = 0$

$+n - F_{grav} = 0$

$n = F_{grav} \Rightarrow n = mg$

Method 1: Work-Energy Theorem: $W_{net} = \Delta KE$

Since motion is horizontal, $\Delta PE = 0$. $\therefore \Delta E = \Delta KE + \Delta PE = \Delta KE$.

$\therefore \Delta E = W_{net} = W_{f_k} = f_k(\cos 180°)(d)$

This method requires solving (b) first!

$\sum F_x = ma \Rightarrow -f_k = ma$

$-\mu_k n = ma$

$-\mu_k mg = ma \Rightarrow a = -\mu_k g$

$a = -(0.692)(9.80\,m/s^2) = -6.782\,m/s^2$

$v^2 = v_0^2 + 2a\Delta x \Rightarrow 0 = v_i^2 + 2ad \Rightarrow d = \dfrac{-v_i^2}{2a} = \dfrac{-(4.90\,m/s)^2}{2(-6.782\,m/s^2)}$

$d = 1.77\,m$ (answer to (b))!

$\therefore \Delta E = -f_k d$

$\Delta E = (78.0\,kg)(-6.782\,m/s^2)(1.77\,m) = -936\,J$

Method 2 for (a): $\Delta E = \Delta KE + \Delta PE = \Delta KE$ since motion is horizontal

$\therefore \Delta E = KE_f - KE_i = 0 - \frac{1}{2}mv_i^2 = -\frac{1}{2}(78.0\,kg)(4.90\,m/s)^2 = -936\,J$

Then for (b): can either use the method shown above (Newton II and Kinematics)

or as already noted $\Delta E = W_{f_k} = f_k(\cos 180°)d = -\mu_k mgd$

so $d = \dfrac{\Delta E}{-\mu_k mg} = \dfrac{-936\,J}{-(0.692)(78.0\,kg)(9.80\,m/s^2)} = 1.77\,m$

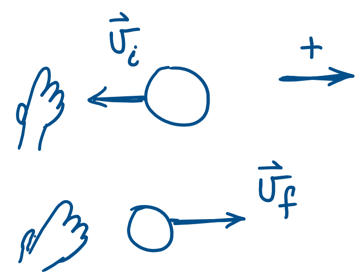
10. - MT-2-B-Alt-10 [4853400]
A volleyball with a mass of 0.269 kg approaches a player horizontally with a speed of 13.0 m/s. The player strikes the ball with her hand, which causes the ball to move in the opposite direction with a speed of 21.8 m/s.

(a) What **magnitude** (no sign) of impulse (in kg·m/s) is delivered to the ball by the player?
9.36 kg·m/s

(b) What is the direction of the impulse delivered to the ball by the player?

- Opposite to the ball's initial velocity
- In the same direction as the ball's initial velocity
- Perpendicular to the ball's initial velocity
- The magnitude is zero.

(c) If the player's hand is in contact with the ball for 0.0600 s, what is the magnitude of the average force (in N) exerted on the player's hand by the ball? 156 N



(a) $\vec{I} = \Delta\vec{p}$

$\vec{I} = \vec{p}_f - \vec{p}_i$

$\vec{I} = m\vec{v}_f - m\vec{v}_i$

$\vec{I} = m(\vec{v}_f - \vec{v}_i)$

$\vec{I} = (0.269\text{ kg})(+21.8\text{ m/s} - (-13.0\text{ m/s})) = +9.361\text{ kg}\cdot\text{m/s} = \boxed{+9.36\text{ kg}\cdot\text{m/s}}$

(b) The impulse delivered to the ball by the hand is opposite to the initial velocity of the ball.

(c) $\vec{I} = \vec{F}\Delta t \Rightarrow \vec{F} = \dfrac{\vec{I}}{\Delta t} = \dfrac{+9.361\text{ kg}\cdot\text{m/s}}{0.0600\text{ s}} = 156\text{ kg}\cdot\text{m/s}^2 = \boxed{156\text{ N}}$