P115 – 2020 – Midterm Examination #2 – Regular 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 <u>three significant figures</u>.

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.

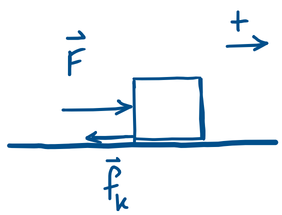
Your WebAssign submission is due no later than 90 minutes after the questions become available and your Canvas submission is due no later than 120 minutes after the questions become available. LATE SUBMISSIONS WILL NOT BE ACCEPTED.

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-R-B-A2 [4853322]
A horizontal force of 7 N in the positive x direction acts on a box of mass 6 kg which slides on a horizontal table with an acceleration in the positive x direction of 0.5 m/s^2. What is the magnitude of the friction force between the box and the table?

- 3 N
- 5 N
- 6 N
- 4 N (correct)
- 2 N



$$\sum F_x = ma_x$$

$$+F - f_k = ma_x$$

$$f_k = F - ma_x$$

$$f_k = 7\text{N} - (6\text{ kg})(0.5\text{ m/s}^2)$$

$$f_k = 4\text{N}$$

3. - MT-2-BZ-A2 [4853294]
Work in the amount of W_1 must be done on an ideal spring to stretch the spring an amount x from its equilibrium length. How much work would be required to stretch this spring an amount $2x$ from its equilibrium length?

- 1.41 W_1
- 8 W_1
- ¼ W_1
- 2 W_1
- 4 W_1 (correct)

$$W_{nc} = (KE_f + PE_f) - (KE_i + PE_i) = PE_f - PE_i \quad (KE_i = KE_f = 0\ ;\ PE_i = 0)$$

$$W_1 = \tfrac{1}{2}kx^2\ ;\quad W_2 = \tfrac{1}{2}k(2x)^2 = \tfrac{1}{2}k(4x^2) = 4\left(\tfrac{1}{2}kx^2\right) = 4W_1$$

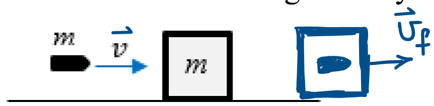
4. - MT-2-S-5A2 [4853288]
Two men are loading crates of food into a van. The crates have the same mass. George lifts his crate straight up from the ground to the van, whereas Matt slides his crate up a ramp on massless, frictionless rollers. Which one of the following statements is true?

- George does more work than Matt.
- Matt does more work than George.
- George and Matt do the same amount of work. (correct)
- None of these statements is necessarily true because the angle of the incline is unknown.
- None of these statements is necessarily true because the mass of one of the crates is not given.

$$W_{nc} = (KE_f + PE_f) - (KE_i + PE_i) \qquad KE_i = KE_f = 0\ ;\ PE_i = 0$$

$W_{nc} = PE_f$ height change is the same for both,
∴ PE_f is the same for both,
∴ Both do the same amount of work.

5. - MT-2-R-B-A6 [4853323]
A bullet of mass m and speed v collides with a block of wood which also has a mass m. The block of wood is initially at rest and the collision is perfectly inelastic, i.e. the bullet sticks in the block of wood. If the initial kinetic energy of the bullet is $Q = ½\, mv^2$, how much kinetic energy is **lost** in the collision? Ignore any loss due to friction between the block of wood and the surface.



Collision ⇒ conservation of momentum

$\vec{P}_{tot_i} = \vec{P}_{tot_f}$

$mv = (m+m)v_f \Rightarrow v_f = \frac{1}{2}v$

- ( ) ✓ ½Q
- ( ) ¼Q
- ( ) (1/3)Q
- ( ) (3/4)Q
- ( ) Q

$$\Delta KE = KE_f - KE_i = \frac{1}{2}(2m)\left(\frac{1}{2}v\right)^2 - \underbrace{\frac{1}{2}mv^2}_{Q} = \frac{1}{4}mv^2 - \frac{1}{2}mv^2 = -\frac{1}{4}mv^2 = -\frac{1}{2}Q$$

∴ Lost KE is $\frac{1}{2}Q$

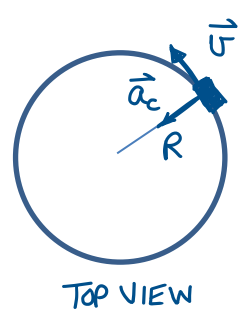
6. - MT-2-S-7A1 [4853293]
Two people are standing on a horizontal circular platform that is rotating (i.e. a merry-go-round). Susan stands at the outer rim of the circular platform, twice as far from the axis of rotation as Bob. When the merry-go-round is rotating at a constant angular speed, how does Susan's angular speed compare to Bob's?

- ( ) Susan's angular speed is half of Bob's.
- ( ) It is impossible to answer this question without having more information.
- ( ) Susan's angular speed is twice Bob's.
- ( ) ✓ Susan's angular speed is the same as Bob's.

The angular speed of every point in a rigid rotating object is the same. (Here the object is the platform, Susan, and Bob.)

7. - MT-2-R-B-A7 [4853324]
When you drive your car around a curve of constant radius at a speed of v the magnitude of the net radial force on your car is F. What must happen to the magnitude of the net radial force on your car if you wish to still make it around the same curve at a speed of $3v$?

- ( ) The net radial force must be 3 times larger.
- ( ) ✓ The net radial force must be 9 times larger.
- ( ) The net radial force must be 18 times larger.
- ( ) The net radial force must be $\sqrt{3}$ times larger.
- ( ) No change is necessary.



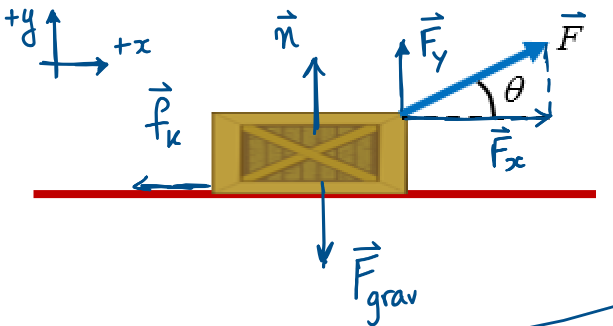
$$\sum F_{r_1} = ma_c = \frac{mv^2}{R}$$

For $v_2 = 3v$: $$\sum F_{r_2} = \frac{mv_2^2}{R} = \frac{m(3v)^2}{R} = 9\,\frac{mv^2}{R} = 9\sum F_{r_1}$$

For constant radius and mass, $\sum F_r \propto v^2$.

8. - MT-2-R-B-B2 [4853325]

A crate is being pulled across the floor with a force F that is at an angle of $\theta = 25.0°$ to the horizontal as shown in the diagram. The crate has a mass of 13.5 kg and the coefficient of kinetic friction between the crate and the floor is 0.840. When the force has a magnitude of $F = 2.63 \times 10^2$ N, calculate the magnitude of the acceleration of the crate. 16.3 m/s^2



Newton II:

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

$$F_x - f_k = ma$$

$$F\cos\theta - f_k = ma$$

need to determine f_k.

$$f_k = \mu_k n$$

need to determine n: $\sum F_y = 0 \Rightarrow +n + F\sin\theta - F_{grav} = 0$

$$n = F_{grav} - F\sin\theta$$

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

$$F\cos\theta - \mu_k n = ma$$

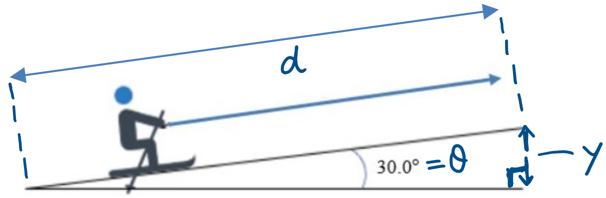
$$F\cos\theta - \mu_k(mg - F\sin\theta) = ma$$

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

$$a = \frac{(263\,\text{N})\cos(25.0°) - (0.840)(13.5\,\text{kg})(9.80\,\text{m/s}^2) + (0.840)(263\,\text{N})(\sin(25.0°))}{13.5\,\text{kg}}$$

$$\boxed{a = 16.3\,\text{m/s}^2}$$

9. - MT-2-BZ-B1 [4853295]
To get to the top of a hill, a skier of mass 78.0 kg holds on to a rope and is pulled up the slope by a motor-driven winch at the top of the hill that winds the rope onto a drum.



(a) How much work is required to pull the skier 55.0 m along a 30.0° frictionless slope at a constant speed of 2.90 m/s? Express your answer in kJ. 21 kJ
(b) What power must the motor deliver to perform this task? 1.11 kW

(a) $W_{nc} = (KE_f + PE_f) - (KE_i + PE_i)$; constant speed $\Rightarrow KE_f = KE_i$

$W_{nc} = PE_f - PE_i = PE_{grav_f} - PE_{grav_i} = mgy$

From the diagram, note that $\sin\theta = \frac{y}{d} \Rightarrow y = d\sin\theta$

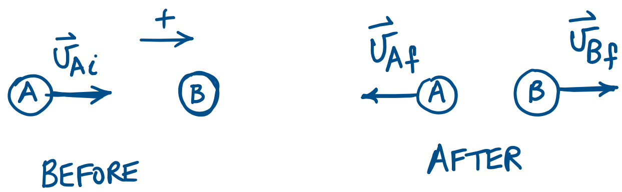
$W_{nc} = mgd\sin\theta = (78.0\text{ kg})(9.80\text{ m/s}^2)(55.0\text{ m})(\sin(30.0°))$

$W_{nc} = 2.10 \times 10^4\text{ J} = \boxed{21.0\text{ kJ}}$

(b) $\bar{P} = \frac{W}{\Delta t}$; $\Delta x = \bar{v}t \Rightarrow t = \frac{d}{v} = \frac{55.0\text{ m}}{2.90\text{ m/s}} = 18.97\text{ s}$

$\bar{P} = \frac{2.102 \times 10^4\text{ J}}{18.97\text{ s}} = 1.11 \times 10^3\text{ W} = \boxed{1.11\text{ kW}}$

10. - MT-2-R-B-A10 [4853327]
Ball A, with mass m, moves in the $+x$ direction with speed V. It collides head-on with ~~another~~ ball B which has a mass that is 4.30 times the mass m. Ball B is initially stationary. After the collision ball A is moving in the $-x$ direction with a speed that is 0.520 times V. Calculate the speed of ball B after the collision. Express your answer as a decimal fraction of V. That is, express your answer as the number by which you must multiply V. 0.353 V



Apply Conservation of Momentum

$$\vec{P}_{tot_i} = \vec{P}_{tot_f} \Rightarrow m_A v_{Ai} + 0 = m_A v_{Af} + m_B v_{Bf}$$

$$mV = m(-0.520V) + (4.30m)v_{Bf}$$

Divide through by m and solve for v_{Bf}

$$1.520V = 4.30 v_{Bf}$$

$$v_{Bf} = \frac{1.520}{4.30}V = \boxed{0.353\,V}$$