HCMC UNIVERSITY
OF TECHNOLOGY AND EDUCATION
FACULTY OF APPLIED SCIENCE

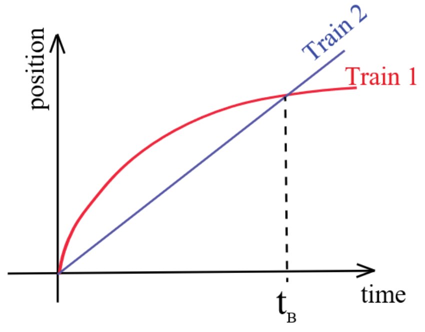
FINAL TEST FOR THE 1st SEMESTER
Academic Year: 2019-2020
Subject: Principles of Physics 1
Date: January 6th 2020
Course number: PHYS130902E
Test number: 01 (2 pages).
Duration: 90 minutes.

Note:
+ Students are allowed to use one A4 double-sided paper sheet of handwritten notes.
+ Invigilators are NOT allowed to explain anything related to the contents of the test.
+ The value of gravitational acceleration is $g=9.80\ m/s^2$ when needed.
+ Questions from 1 to 4 are multiple choice. Write the letter A, B, C, D, or E related to your choice(s) on your answer sheet

Question 1 (0.5 marks)

The graph shows the position as a function of time for two trains running on parallel tracks. For times greater than t =0, which of the following is true:

A. At time t_B, both trains have the same instantaneous velocity.
B. The speed of both trains increases all the time.
C. Both trains have the same instantaneous velocity at some time before t_B.
D. Somewhere on the graph, the velocities of both trains are changing in the same way.



Question 2 (0.5 marks)

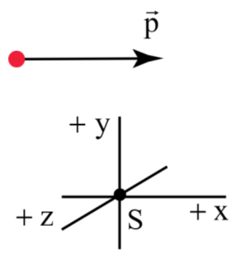
Two carts of masses m and $2m$ are at rest on a horizontal and frictionless surface. Both carts are pushed with equal forces for the same time interval. At the end of the time interval, the kinetic energy of the cart of mass m is

A. one fourth of the kinetic energy of the cart with mass $2m$.
B. one half the kinetic energy of the cart with mass $2m$.
C. equal to the kinetic energy of the cart with mass $2m$.
D. twice the kinetic energy of the cart with mass $2m$.
E. four times the kinetic energy of the cart with mass $2m$.

Question 3 (0.5 marks)

As a particle moves in the positive x-direction with a constant momentum, the magnitude of the angular momentum about the point S (the origin):

A. decreases and then increases.
B. increases and then decreases.
C. is constant.
D. is zero because this is not circular motion.



Question 4 (0.5 marks)

A Carnot heat engine runs between a cold reservoir at temperature T_c and a hot reservoir at temperature T_h. You want to increase its efficiency. Of the following, which change results in the greatest increase ~~in~~ efficiency? The value of ΔT is the same for all changes.

A. Lower the temperature of the hot reservoir by ΔT
B. Lower the temperature of the cold reservoir by ΔT
C. Raise the temperature of the hot reservoir by ΔT
D. Raise the temperature of the cold reservoir by ΔT

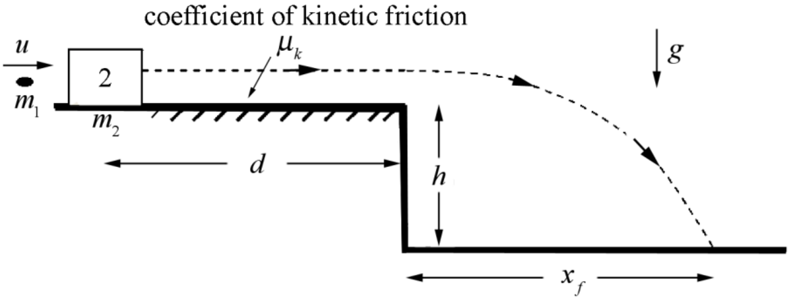
Question 5 (1.0 marks)

In a collision between two cars, which would you expect to be more damaging to the occupants: if the cars collide and remain together, or if the two cars collide and rebound backward? Explain.

<u>Question 6</u> <u>(1.0 marks)</u>

Roofs of houses are sometimes "blown" off (or are they pushed off?) during a tornado or hurricane. Explain.

<u>Question 7</u> <u>(2.0 marks)</u>

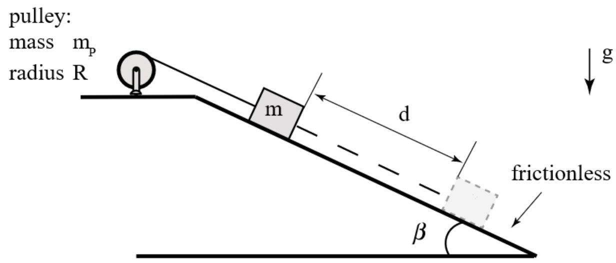


A bullet of mass m_1 traveling horizontally with speed u hits a block of mass m_2 that is originally at rest and becomes embedded in the block. After the collision, the block slides a distance d horizontally on a surface with friction , and then falls off the surface at a height h, as shown. The coefficient of kinetic friction between the block and the surface is μ_k. Assume the collision is nearly instantaneous, and all distances are large compared to the size of the block. Neglect air resistance.

a. What is u_{min}, the minimum speed of the bullet, so that the block falls off the surface?

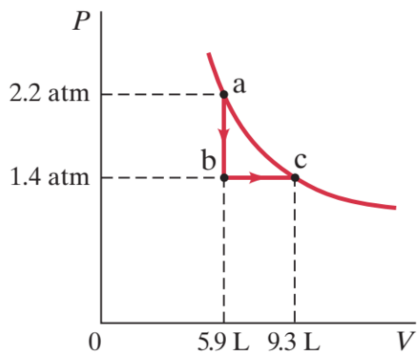
b. Assume that the initial speed of the bullet u is large enough for the block to fall off the surface. Calculate x_f, the position where the block hits the ground measured from the bottom edge of the surface, in terms of some or all of the following: $u, m_1, m_2, \mu_k, d, h, g$.

<u>Question 8</u> <u>(2.0 marks)</u>



Consider a pulley of mass m_p and radius R that has a moment of inertia $\frac{1}{2}m_pR^2$. The pulley is free to rotate about a frictionless pivot at its center. A massless string is wound around the pulley and the other end of the rope is attached to a block of mass m that is initially held at rest on frictionless inclined plane that is inclined at an angle β with respect to the horizontal. The downward acceleration of gravity is g . The block is released from rest. How long does it take the block to move a distance d down the inclined plane?

<u>Question 9</u> <u>(2.0 marks)</u>



Consider the following ***two-step*** process. Heat is allowed to flow out of an ideal gas at constant volume so that its pressure drops from 2.2 atm to 1.4 atm. Then the gas expands at constant pressure, from a volume of 5.9 L to 9.3 L, where the temperature reaches its original value. Calculate

(a) the total work done by the gas in the process,

(b) the change in internal energy of the gas in the process, and

(c) the total heat flow into or out of the gas.

$1\ atm = 1.01 \times 10^5 Pa = 1.01 \times 10^5 N/m^2$

ELO of the subject (knowledge)	Test contents
[ELO 1.1]: Understanding various concepts, theorems, and laws related to classical mechanics, fluid mechanics and wave motion	Questions: No. 1, 2, 3, 5, 6, 7, 8
[ELO 2.1]: Applying the knowledge and skills required to solve the problems in mechanics.	Questions: No. 1, 2, 3, 5, 6, 7, 8
[ELO 2.3]: Applying the principles of thermodynamics to explain the phenomena related to the temperature as well as solving the related problems.	Question: No. 4, 9

30th December 2019

Head of Department

KEYS AND SCORES
For Questions in Final Exam of Principles of Physics 1
Edited by: Nguyen Huu Nha

Question	Answer	Mark
1	**C**. When the tangent line to the curve of train 1 is parallel to the line of train 2.	0.5
2	**D**. $\Delta p = F\Delta t \to p_1 = p_2 \to \frac{p_1^2}{2m} = 2\frac{p_2^2}{2(2m)} \to K_1 = 2K_2$	0.5
3	**C.** $L = pd = const$. The distance from the origin to the direction of p is unchanged.	0.5
4	**B.** $e = \frac{T_h - T_c}{T_h} = 1 - \frac{T_c}{T_h} \to e_B = 1 - \frac{T_c - \Delta T}{T_h} = e + \frac{\Delta T}{T_h}; e_C = 1 - \frac{T_c}{T_h + \Delta T} = e + \frac{T_c}{T_h} - \frac{T_c}{T_h + \Delta T} = e + \frac{\Delta T}{T_h}\frac{T_c}{T_h + \Delta T} < e_B$	0.5
5	The collision in which the **two cars rebound** would probably be **more damaging**. In the case of the cars rebounding, the **change in momentum** of each car **is greater** than in the case in which they stick together because each car is not only brought to rest but also sent back in the direction from which it came. A **greater impulse** results from a **greater force**, and so most likely more damage would occur.	1.0
6	During a hurricane or tornado, the **outside air pressure** may **drop** suddenly because of the **high wind speeds**, as shown by **Bernoulli's principle**. The **greater air pressure inside** the house may then **push the roof off**.	1.0
7	a. Conservation of momentum: $m_1 u = (m_1 + m_2)v_i \to v_i = \frac{m_1}{m_1 + m_2}u$	0.5
	Conservation of energy: $\Delta K + \Delta E_{int} = 0 \to \frac{1}{2}(m_1 + m_2)v_f^2 - \frac{1}{2}(m_1 + m_2)v_i^2 + \mu_k(m_1 + m_2)gd = 0$	0.5
	$\to v_f^2 = v_i^2 - 2\mu_k gd \geq 0 \to v_i \geq \sqrt{2\mu_k gd} \to (v_i)_{min} = \sqrt{2\mu_k gd} \to u_{min} = \frac{m_1 + m_2}{m_1}\sqrt{2\mu_k gd}$	0.25
	b. The velocity at the edge: $$v_f^2 = v_i^2 - 2\mu_k gd = \left(\frac{m_1}{m_1 + m_2}u\right)^2 - 2\mu_k gd$$	0.25
	The equation for the projectile: $$\begin{cases} x = v_f t \\ y = -\frac{1}{2}gt^2 + h \end{cases} \to y = 0 \to t = \sqrt{\frac{2h}{g}} \to$$	0.25
	$$x_f = v_f t = v_f\sqrt{\frac{2h}{g}} = \sqrt{\frac{2h}{g}\left[\left(\frac{m_1}{m_1 + m_2}u\right)^2 - 2\mu_k gd\right]}$$	0.25
8	*Method 1*: Conservation of energy: $$\Delta K + \Delta U = 0 \to \left(\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 - 0\right) - mgd\sin\beta = 0$$	0.5
	$$\to \frac{1}{2}mv^2 + \frac{1}{2}\frac{1}{2}m_pR^2\left(\frac{v}{R}\right)^2 = mgd\sin\beta \to v^2\frac{(2m + m_p)}{4} = mgd\sin\beta$$ $$\to v^2 = \frac{4mgd\sin\beta}{2m + m_p}$$	0.5
	The time for the mass *m* to slide: $$x = \frac{v_i + v_f}{2}t$$	0.5
	$$\to t = \frac{2d}{v} = 2d\sqrt{\frac{2m + m_p}{4mgd\sin\beta}} = \sqrt{\frac{d(2m + m_p)}{mg\sin\beta}}$$	0.5
	Method 2:We can use Newton's equations to find the acceleration and find the time	

9	a. the total work done on the gas in the process: $W_{abc} = W_{ab} + W_{bc} = 0 - \int_{5.9}^{9.3} 1.4dV\ = -1.4 \times 1.01 \times 10^5(9.3 - 5.9) \times 10^{-3} = -480J$ The work done by the gas is 480J b. the change in internal energy of the gas in the process, and $\Delta E_{abc} = \Delta E_{ac} = 0$ Because the internal energy is a state variablel and depends only on the temperature . c. the total heat flow into or out of the gas. $\Delta E_{abc} = Q_{abc} + W_{abc} = 0$ $\rightarrow Q_{abc} = -W_{abc} = 480J$ The heat of 482 J flows into the gas.	0.5 0.25 0.25 0.25 0.25 0.25 0.25