HCMC UNIVERSITY OF TECHNOLOGY AND EDUCATION
Faculty for High Quality Training

FINAL EXAMINATION
SEMESTER 2 – ACADEMIC YEAR 2018-2019
Course name: **Principles of Physics 1**
Course ID: PHYS130402
Exam code: 01 Number of pages: 02
Duration: 90 minutes.

Note: + Proctors are not allowed to give any unauthorised explanation.
+ Students are allowed to use one A4 paper sheet as a memory aid.

Question 1: (0.5 marks/10)

Which one of the following statements is true?

a. If a car is traveling eastward, its acceleration must be eastward.
b. If a car is slowing down, its acceleration must be negative.
c. A particle with constant acceleration can never stop and stay stopped.

Question 2: (0.5 marks/10)

Two objects have equal kinetic energies. How do the magnitudes of their momenta compare?

a. $p_1 < p_2$
b. $p_1 = p_2$
c. $p_1 > p_2$
d. not enough information to tell.

Question 3: (0.5 marks/10)

A block of mass *m* is dropped from the fourth floor of an office building and hits the sidewalk below at speed v. From what floor should the block be dropped to double that impact speed?

a. The sixth floor
b. The eighth floor
c. The tenth floor
d. The twelfth floor
e. The sixteenth floor

Question 4: (0.5 marks/10)

An engine does 15.0 kJ of work while exhausting 37.0 kJ to a cold reservoir. What is the efficiency of the engine?

a. 15.0 %
b. 28.8 %
c. 33.3 %
d. 45.0 %

Question 5: (1.0 mark/10)

A person holds a ball in her hand. Identify all the external forces acting on the ball and the Newton’s third-law reaction force to each one.

Question 6: (1.0 mark/10)

If global warming continues over the next one hundred years, it is likely that some polar ice will melt and the water will be distributed closer to the equator. How would that change the moment of inertia of the Earth and the duration of the day (one revolution)?

Question 7: (2.0 marks/10)

A 0.6 kg particle has a speed of 2.0 m/s at point A and kinetic energy of 7.5 J at point B.

a. What is its kinetic energy at A?
b. What is its speed at B?
c. What is the net work done on the particle by external forces as it moves from A to B?

Question 8: (2.0 marks/10)

A block of mass m_1 = 2.00 kg and a block of mass m_2 = 6.00 kg are connected by a massless string over a pulley in the shape of a solid disk having radius R = 0.250 m and mass M = 10.0 kg. The fixed, wedgeshaped ramp makes an angle of θ = 30.0° as shown in Figure 1. The coefficient of kinetic friction is 0.360 for both blocks.

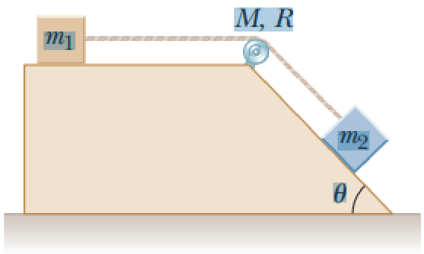


Figure 1.

a. Draw force diagrams of both blocks and of the pulley.

b. Determine the acceleration of the two blocks.

c. Determine the tensions in the string on both sides of the pulley.

The magnitude of the free-fall acceleration is g = 9.80 m/s². $g = 9.80\ m/s^2$

Question 9: (2.0 marks/10)

A sample of an ideal gas goes through the process shown in Figure 2. From A to B, the process is adiabatic; from B to C, it is isobaric with 345 kJ of energy entering the system by heat; from C to D, the process is isothermal; and from D to A, it is isobaric with 371 kJ of energy leaving the system by heat.

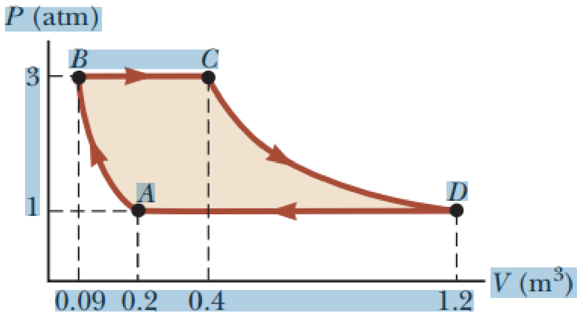


Figure 2.

a. Determine the work done by the gas in the process from B to C.

b. Determine the work done on the gas in the process from D to A.

c. Determine the difference in internal energy $E_{int,B} - E_{int,A}$.

1 atm = 1.013×10^5 *Pa*

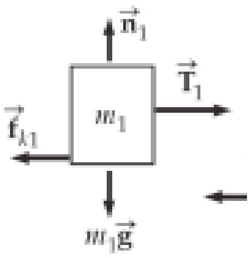
Learning outcome mapping	**Assessed in**
[ELO 1.1]: Understanding various concepts, theorems, and laws related to classical mechanics and fluid mechanics. [ELO 3.1]: To express the learned knowledge by problem solving capability and answer questions related to the concepts learned.	Questions 1, 2, 3, 5, 6, 7, 8
[ELO 2.1]: Applying the knowledge and skills required to solve the problems in mechanics. [ELO 3.1]: To express the learned knowledge by problem solving capability and answer questions related to the concepts learned.	Questions 3, 6, 7, 8
[ELO 2.1]: Applying the principles of thermodynamics to explain the phenomena related to the temperature as well as solving the related problems. [ELO 3.1]: To express the learned knowledge by problem solving capability and answer questions related to the concepts learned.	Question 4, 9

26/5/2019

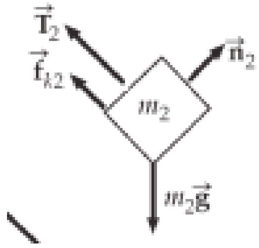
Approved by program chair

(signed and named)

KEYS AND SCORES FOR QUESTIONS
Final Exam of Principles of Physics 1
Edited by: Do Quang Binh

Question	**Answer**	**Marks**
1	c	0.5
2	d	0.5
3	e	0.5
4	b	0.5
5	Force: the *Earth* attracts the *ball* downward with the force of gravity. Reaction force: the *ball* attracts the *Earth* upward with the force of gravity. Force: the *hand* pushes up on the *ball*. Reaction force: the *ball* pushes down on the *hand*.	0.25 0.25 0.25 0.25
6	-The Earth is an isolated system in terms of angular momentum, so its angular momentum is conserved when the distribution of its mass changes. -When its mass moves away from the axis of rotation (closer to the equator), its moment of inertia increases, -and its angular speed decreases, -so its period increases, then the duration of the day is longer. But most of the mass of Earth would not move, so the effect would be small.	0.25 0.25 0.25 0.25
7	**a.** Kinetic energy at A $K_A = \frac{1}{2}(0.600 \text{ kg})(2.00 \text{ m/s})^2 = \boxed{1.20 \text{ J}}$ **b.** Speed at B $\frac{1}{2}mv_B^2 = K_B: \ v_B = \sqrt{\frac{2K_B}{m}} = \sqrt{\frac{(2)(7.50 \text{ J})}{0.600 \text{ kg}}} = \boxed{5.00 \text{ m/s}}$ **c.** The net work done on the particle by external forces as it moves from A to B $\sum W = \Delta K = K_B - K_A = \frac{1}{2}m\left(v_B^2 - v_A^2\right) = 7.50 \text{ J} - 1.20 \text{ J} = \boxed{6.30 \text{ J}}$	0.5 0.5 1.0
8	**a.** *The force diagram of block m_1*  $m_1\vec{g}$ is the gravitational force the Earth acts on the block $\vec{n}_1$ is the normal force exerted by the surface on the block. $\vec{T}_1$ is the force the string exerts on the block. $\vec{f}_{k1}$ is the force of kinetic friction the surface exerts on the block.	

The force diagram of block m_2



$m_2\vec{g}$ is the gravitational force the Earth acts on the block

$\vec{n}_2$ is the normal force exerted by the surface on the block.

$\vec{T}_2$ is the force the string exerts on the block.

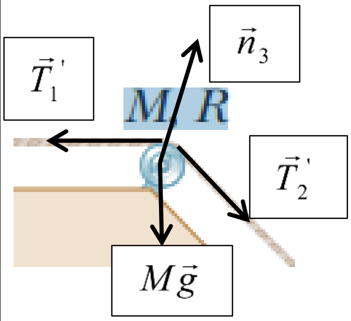
$\vec{f}_{k2}$ is the force of kinetic friction the surface exerts on the block.

The force diagram of the pulley

$M\vec{g}$ is the gravitational force the Earth acts on the pulley

$\vec{n}_3$ is the normal force exerted by the surface on the pulley.

$\vec{T}_1^{'}, \vec{T}_2^{'}$ are the forces the string exerts on the pulley.



0.5

b. The acceleration of the two blocks

Note that both the blocks have the accelerations of the same magnitude a; if the string does not slide on the pulley, the magnitude α of the angular acceleration of the pulley and the magnitude a of the accelerations of the blocks are related by the equation

$$a = R\alpha$$

The magnitudes of the forces $\vec{T}_1^{'}$ and $\vec{T}_1$ are equal; the magnitudes of the forces $\vec{T}_2^{'}$ and $\vec{T}_2$ are equal as well:

$$T'_1 = T_1 \quad \text{and} \quad T'_2 = T_2$$

For m_1,

$\sum F_y = ma_y$ gives

$$n_1 - m_1 g = 0$$

$$n_1 = m_1 g$$

with $f_{k1} = \mu_k n_1$

	$\sum F_x = ma_x$ gives $-f_{k1} + T_1 = m_1 a$ **[1]**	0.25
	For the pulley, $\sum \tau = I\alpha$ gives $-T_1R + T_2R = \frac{1}{2}MR^2\left(\frac{a}{R}\right)$ or $-T_1 + T_2 = \frac{1}{2}MR\left(\frac{a}{R}\right) \rightarrow -T_1 + T_2 = \frac{1}{2}Ma$ **[2]**	0.25
	For m_2, $+n_2 - m_2 g\cos\theta = 0 \rightarrow n_2 = m_2 g\cos\theta$ $f_{k2} = \mu_k n_2$ $-f_{k2} - T_2 + m_2 g\sin\theta = m_2 a$ **[3]**	0.25
	Add equations [1], [2], and [3] and substitute the expressions for f_{k1} and n_1, and $-f_{k2}$ and n_2: $-f_{k1} + T_1 + (-T_1 + T_2) - f_{k2} - T_2 + m_2 g\sin\theta = m_1 a + \frac{1}{2}Ma + m_2 a$ $-f_{k1} - f_{k2} + m_2 g\sin\theta = \left(m_1 + m_2 + \frac{1}{2}M\right)a$ $-\mu_k m_1 g - \mu_k m_2 g\cos\theta + m_2 g\sin\theta = \left(m_1 + m_2 + \frac{1}{2}M\right)a$ $a = \frac{m_2(\sin\theta - \mu_k\cos\theta) - \mu_k m_1}{m_1 + m_2 + \frac{1}{2}M}g$ $a = \frac{(6.00\text{ kg})(\sin 30.0^\circ - 0.360\cos 30.0^\circ) - 0.360(2.00\text{ kg})}{(2.00\text{ kg}) + (6.00\text{ kg}) + \frac{1}{2}(10.0\text{ kg})}g$ $a = \boxed{0.309\text{ m/s}^2}$	0.25
	c. The tensions in the string on both sides of the pulley From equation [1]: $-f_{k1} + T_1 = m_1 a \rightarrow T_1 = 2.00\text{ kg}(0.309\text{ m/s}^2) + 7.06\text{ N} = \boxed{7.67\text{ N}}$	0.25
	From equation [2]: $-T_1 + T_2 = \frac{1}{2}Ma \rightarrow T_2 = 7.67\text{ N} + 5.00\text{ kg}(0.309\text{ m/s}^2)$ $= \boxed{9.22\text{ N}}$	0.25
9	**a. The work done by the gas in the process from B to C** $-W_{BC} = P_B.\Delta V_{BC} = P_B(V_B - V_C) = 3\times1.013\times10^5(0.4 - 0.09) =$ $= 9.42\times10^4$ J	0.5
	b. The work done on the gas in the process from D to A	

	$W_{DA} = -P_D.\Delta V_{DA} = -P_D(V_A - V_D) = -1\times1.013\times10^5(0.2 - 1.2) =$ $= 1.013\times10^5$ J **c. The difference in internal energy $E_{int,B}$ - $E_{int,A}$** Because the gas goes through a cycle, the overall change in internal energy must be zero: $$\Delta E_{int} = \Delta E_{int,AB} + \Delta E_{int,BC} + \Delta E_{int,CD} + \Delta E_{int,DA} = 0$$ $$\rightarrow \Delta E_{int,AB} = -\Delta E_{int,BC} - \Delta E_{int,CD} - \Delta E_{int,DA}$$ Recognize that $\Delta E_{int} = 0$ for the isothermal process CD and substitute from the first law for the other internal energy changes: $\Delta E_{int,AB} = -\Delta E_{int,BC} - \Delta E_{int,DA}$ $= -(Q_{BC} + W_{BC}) - (Q_{DA} + W_{DA})$ $= -(345$ kJ $- 94.2$ kJ$) - (-371$ kJ $+ 101.3$ kJ$)$ $= 18.9$ kJ	0.5 0.5 0.5