Jimma University

College of Natural Sciences

Department of Physics

General Physics (Phys 1**0**11) Final Exam

Year: 2**0**20/2**0**21 academic calendar

Semester: I

Prepared by instructors: All lecturers offering the course

Date: September 06, 2**0**21

Time allowed: 2hrs

Name of the student: __Answer key_____ Section ___ ID_____

Campus: _____All Campus_____

General direction

1. This exam contains five parts: i) True or False items, ii) Matching item, iii) Multiple choice item, iv) Short answer item and v) Work out item.
   — Read carefully instructions for each item to work.
2. Provide your answers for items from i) to iv) on the space provided. For item (v)-the workout problems do on the attached paper.
3. Do not forget to write the name of your instructor on the space provided.
4. No any calculating machine is allowed
5. Cheating is strictly forbidden.
6. No rough paper is allowed.
7. Check that the booklet has 7 pages.

I. TRUE OR FALSE QUESTIONS

Write **TRUE** if the statement is correct, and write **FALSE** if the statement is incorrect on the blank space.

1. __TRUE__ A person in a freely falling apparatus in earth's gravity feels weightless.
2. __FALSE__ All of the three Newton's laws of motion should consider both external and internal forces to the object under consideration.
3. __FALSE__ Bulk modulus measures the resistance of solids to change tensile stress.
4. __FALSE__ By the work–kinetic energy theorem, the work done by external forces on a system is equal to the work done by dissipative forces acted on the system.
5. __TRUE__ If two or more particles in an isolated system interact, the total momentum of the system remains the same.

II. MATCHING

Match the best from **column B** to **column A** by writing the letter of your answer on the blank spaces (only one best match), next to the number under **A.**

Column A	Column B
1. __D__ Always conserved	A. Constant velocity
2. __I__ Viscous	B. Kinetic energy
3. __H__ Uniform circular motion	C. Momentum
4. __F__ Impulse	D. Energy
5. __J__ Power	E. Mechanical energy
	F. Change in momentum
	G. Laminar flow
	H. Change in kinetic energy is zero
	I. Turbulent flow
	J. None

III. MULTIPLE CHOICE

Choose the correct alternatives based on the question and provide the letter of your choice in front of the question number (only in capital letters).

C **1.** For uniform circular motion, which of the following correctly describes the centripetal acceleration?

A. constant and always perpendicular to the velocity vector
B. constant and always parallel to the velocity vector
C. of constant magnitude and always perpendicular to the velocity vector
D. of constant magnitude and always parallel to the velocity vector
E. None

E 2. If the net work done by external forces on a particle is zero, then which of the following is true about the particle?

A. Its velocity is zero.
B. Its velocity is decreased.
C. It is in uniform circular motion.
D. Its potential energy is unchanged.
E. Its speed is unchanged.

B 3. Abdisa and Abebe are loading identical cabinets onto a truck. Abebe lifts his cabinet straight up from the ground to the bed of the truck, whereas Abdisa slides his cabinet up a rough ramp to the truck. Which statement is correct about the work done on the cabinet-Earth system? (Assume no air resistance.)

A. Both Abdisa and Abebe do the same amount of work.
B. Abdisa does more work than Abebe.
C. Abebe does more work than Abdisa.
D. None of those statements is necessarily true since the displacements are not given.
E. Impossible to judge.

D 4. If the speed of a particle is halved, whereas its mass is quadrupled then which of the following is correct?

A. The particle's kinetic energy is halved while its momentum is doubled.
B. The particle's kinetic energy is doubled while its momentum is halved.
C. Both the particle's kinetic energy and momentum remains the same.
D. The particle's kinetic energy remains the same while its momentum is doubled.
E. The particle's kinetic energy is quadrupled while its momentum is doubled.

C 5. Which of the following forces, if any, does no work on a simple pendulum that swings back and forth about a vertical position just above the surface of the earth at any time?

A. the gravitational force
B. air resistance
C. the tension in the supporting cord
D. both the gravitational force and the tension in the supporting cord
E. none

D 6. A 5-kg cart moving to the right with a speed of 6 m/s collides with a concrete wall and rebounds with a speed of 2 m/s. What is the change in momentum of the cart?

A. 240 kg.m/s B. 230 kg.m/s C. 210 kg.m/s D. 40 kg.m/s E. Zero

A 7. A truck loaded with sand accelerates along a highway. The driving force on the truck remains constant. What happens to the acceleration of the truck if additional load is added to it?

A. decreases B. increases C. increases and then decreases
D. decreases and then increases E. remains constant

E 8. A particle moves in a circular path of radius r with speed v. It then increases its speed to $2v$ while traveling along the same circular path. Which one of the following is correct?

A. The centripetal acceleration of the particle is halved
B. The period of the particle is quadrupled
C. The centripetal acceleration of the particle is doubled
D. The period of the particle is tripled

E. The period of the particle is halved

B 9. The statement, "When pressure is applied to an enclosed fluid, the pressure is transmitted undiminished to every point in the fluid and to every point on the walls of the container." is

A. Archimedes's Principle
B. Pascal's Principle
C. Bernoulli's Principle
D. Torricelli's Principle
E. None

A 10. A satellite originally moves in a circular orbit of radius R around the Earth. If, it is moved into a circular orbit of radius 4R, then which of the following is true about the satellite?

A. The satellites weight will be decreased.
B. The force exerted on the satellite will be increased.
C. The speed of the satellite will be increased.
D. The speed of the satellite remains the same.
E. None.

IV. SHORT ANSWER QUESTIONS

Give short and brief answers to the following questions on the space provided.

1. State Kepler's third law of planetary motion. The square of the period of a planet moving around the sun is proportional to the cube of the semi-major axis of the elliptical orbit.
2. The velocity of a particle at an instant of time is $\vec{v}$ while a net force $\vec{F}$ is acting on it at the time. The power imparted on the particle at this time is given by $\vec{F} \cdot \vec{v}$
3. What quantities are being conserved in an elastic collision?
   Both momentum and kinetic energy.
4. The pressure in a fluid at rest varies with density, depth and gravitational acceleration.
5. State Newton's Universal law of gravitation Any two objects in the universe attract each other with a force whose magnitude is proportional to the product of the masses of the objects and inversely proportional to the square of the distance between the objects.

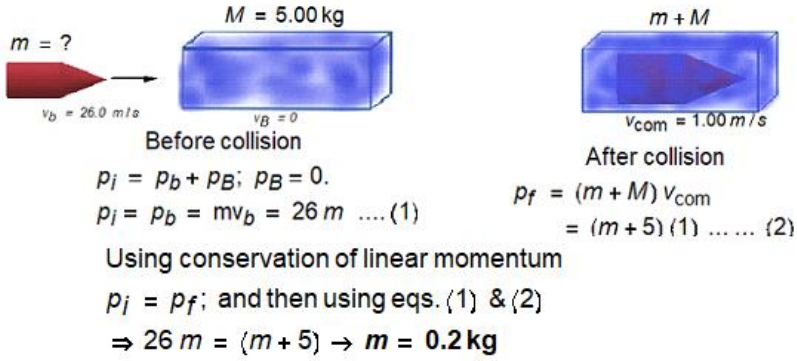
V. WORK OUT

Do all the problems. Show your steps clearly and precisely. Also, roughly sketch the model diagrams of the problems and free-body diagrams.

Constants may be used are: $\boldsymbol{\pi = 3.14}$; $\boldsymbol{g = 9.80 m/s^2}$.

1. A bullet of mass *m* is fired with speed of 26.00m/*s* into a stationary wooden block of mass, M = 5.00kg. The bullet imbeds into the block. The speed of the bullet-plus-wood combination immediately after the collision is 1.00m/s. What is the mass *m* of the bullet?

Answer Q#1



2. For the system depicted as in the Figure 1, the blocks on the horizontal table are in contact with one another. The first block, M_1, is connected to a massless string that passes over a massless and frictionless pulley, fastened to a hanging object of mass M.

a) Assuming the surface of the table as frictionless

i) determine the acceleration of the system.

ii) find the interaction forces between M_1 & M_2.

b) Assuming the surface of the table to possess friction of uniform kinetic coefficient μ_k, if the system accelerates,

i) determine the acceleration of the system.

ii) find the interaction forces between M_1 & M_2.

(**Hint:** Here your expressions may contain M_1, M_2, M, g and μ_k).

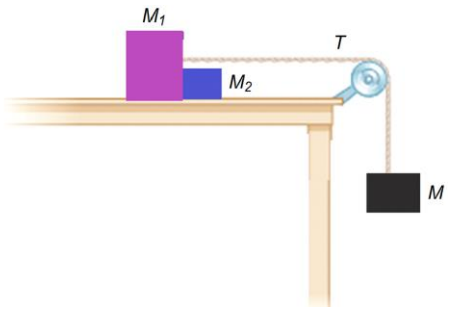
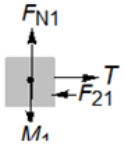


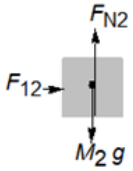
Figure 1

Answer Q#2

2. a) For frictionless surface : Free body diagrams and the corresponding equations



$$T - F_{21} = M_1 a \quad \ldots. (1)$$



$$F_{12} = M_2 a \quad \ldots. (2)$$



$$Mg - T = M a \quad \ldots. (3)$$

By Newton's third law : $F_{21} = F_{12}$ .... (4)

The solutions of the simultaneous equations from (1) – (4)

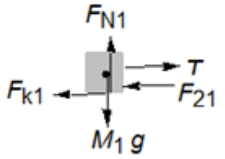
$$\Rightarrow \; i) \; a = \frac{M \times g}{M + M_1 + M_2}$$

$$ii) \; F_{12} = F_{21} = \frac{M \times M_2 g}{M + M_1 + M_2}$$

2. ...

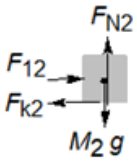
***b*) When there is friction on the horizontal surface :**

Free body diagrams and the corresponding equations



$$T - F_{21} - F_{k1} = M_1 a \quad \ldots. (1)$$

$$F_{k1} = \mu_k F_{N1} = \mu_k M_1 g \quad \ldots. (2)$$



$$F_{12} - F_{k2} = M_2 a \quad \ldots. (3)$$

$$F_{k2} = \mu_k F_{N2} = \mu_k M_2 g \quad \ldots (4)$$



$$Mg - T = M a \quad \ldots. (5)$$

By Newton's third law : $F_{21} = F_{12}$ .... (6)

The solutions of the simultaneous equations from (1) – (6)

$$\Rightarrow \; i) \; a = \frac{[M - \mu_k(M_1 + M_2)]\, g}{M + M_1 + M_2}$$

$$ii) \; F_{12} = F_{21} = \frac{M \times M_2(1 + \mu_k)\, g}{M + M_1 + M_2}$$

3. The Venturi tube shown in *Figure 2* is considered as a fluid flow meter. Suppose the device is used at a service station to measure the flow rate of gasoline ($\rho = 7.0 \times 10^2$ kg/m^3) through an outlet hose of radius 1.20 cm. If the difference in pressure is measured to be $P_1 - P_2 = 5.25 \times 10^3$ Pa and the radius of the inlet tube to the meter is 2.40cm, find

   (a) the speed of the gasoline as it leaves the hose and

   (b) the fluid flow rate in cubic meters per second

   (Hint: ***Assume the tube is horizontal***.)

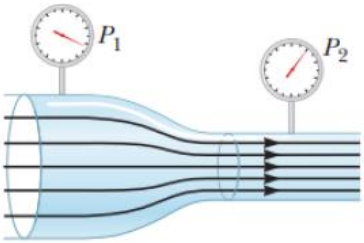


Figure 2

Answer Q#3

Given : $r_{inlet} \equiv r_1 = 2.40\ cm = 2.40 \times 10^{-2}\ m;$

$r_{out} \equiv r_2 = 1.20\ cm = 1.20 \times 10^{-2}\ m;$

$\rho = 7.00 \times 10^2\ kg/m^3;$

$\triangle P \equiv p_1 - p_2 = 5.25 \times 10^3\ Pa;$

Required : $a)\ v_{out} = ?$

$b)$ Volume flow rate $= A \times v = ?$

Solution :

Continuity equation : $A_1 v_1 = A_2 v_2$

$$\Rightarrow v_1 = \frac{A_2 v_2}{A_1} = \frac{\pi \times r_2^2}{\pi \times r_1^2} \times v_2 = v_2 \times \left(\frac{r_2}{r_1}\right)^2$$

$$\Rightarrow v_1 = \frac{v_2}{4} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

By Bernoulli's principle :

$$P_1 + \frac{1}{2} \times \rho \times v_1^2 + \rho \times g \times h_1 = P_2 + \frac{1}{2} \times \rho \times v_2^2 + \rho \times g \times h_2 \ldots (2)$$

Note : the tube is horizontal.

$h_1 = h_2$, so eqn. (2) implies

$$\triangle P = P_1 - P_2 = \frac{1}{2} \times \rho \times \left(v_2^2 - v_1^2\right) \ldots\ldots\ldots (3)$$

Plugging eq. (1) in eq. (3), one obtains

$$\triangle P = \frac{15}{32} \times \rho \times v_2^2.$$

Then, substituting the given values

$a)\ v_2 = 4.00\ m/s.$

$b)$ Volume flow rate $= A \times v = A_1 \times v_1 = A_2 \times v_2 = \pi \times r_2^2 \times v_2$

$$= 1.81 \times 10^{-3}\ m^3/s \text{ or } 1.81 \times 10^3\ cm^3/s$$