UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS (APK)

MODULE: PHY1A1E

INTRODUCTORY PHYSICS 1A1E/1EA1

JULY EXAM

DATE: JULY 2019
2.5 Hours

	Student's Mark	Question's Mark
A		10
Q 1		28
Q 2		20
Q3		13
Q4		29
Total		100

EXAMINER/SECOND EXAMINER/MODERATOR **Mr. P. Molefe**
Dr. B.M. Sondezi
Mr. N.M. Khwanda

TIME 150 MINUTES

MARKS **100**

INSTRUCTIONS: ANSWER ALL THE QUESTIONS IN THE SPACES PROVIDED.
NUMBER OF PAGES: 16 INCLUDING COVER PAGE
REQUIREMENTS: SCIENTIFIC CALCULATOR, NO PROGRAMMABLE CALCULATORS ARE ALLOWED. No pencil answers will be accepted

Student Number										

ID Number													

Surname and Initials: _____

Contact Number: _____

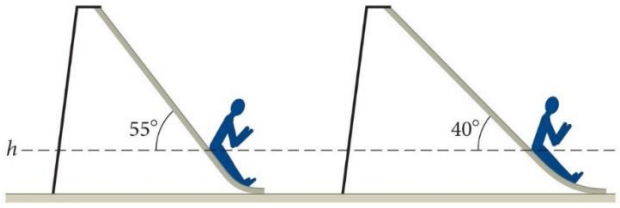
Venue: _____

1.1	**A**	**B**	**C**	**D**	**E**
1.2	**A**	**B**	**C**	**D**	**E**
1.3	**A**	**B**	**C**	**D**	**E**
1.4	**A**	**B**	**C**	**D**	**E**
1.5	**A**	**B**	**C**	**D**	**E**

SECTION A [10]

Instructions:
This is a multiple choice question. Indicate your answer by circling the correct answer on the answer sheet provided in page 1.

1.1 Two children at a playground slide from rest down slides that are of equal height but are inclined at different angles with respect to the horizontal as shown in the figure. Ignoring friction, at height h above the ground, which child has the greater acceleration?



A. The child on the left
B. The child on the right
C. Both have the same acceleration.
D. We need additional information.
E. Can't have the same acceleration.

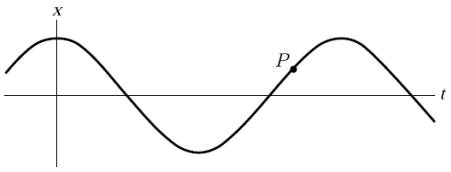
1.2 If a nonconservative force acts on an object, and does work, then

A. the object's kinetic energy is conserved,
B. the object's potential is conserved,
C. the mechanical energy is conserved,
D. the mechanical energy is not conserved,
E. None of the above.

1.3 A restoring force of magnitude F acts on a system with a displacement of magnitude x. In which of the following cases will the system undergo simple harmonic motion?

A. $F \propto \sqrt{x}$
B. $F \propto \sin x$
C. $F \propto x^2$
D. $F \propto x$
E. $F \propto 1/x$

1.4 A mass attached to a spring oscillates back and forth as indicated in the position vs. time plot below. At point *P*, the mass has:



A. positive velocity and positive acceleration.
B. positive velocity and negative acceleration.
C. positive velocity and zero acceleration.
D. negative velocity and zero acceleration.
E. zero velocity but is accelerating (positively or negatively).

1.5 Two identical symmetric pulses of opposite amplitude travel along a stretched string and interfere destructively. Which of the following is/are true?

A. There is an instant at which the string is completely straight.
B. When the two pulses interfere, the energy of the pulses is momentarily zero.
C. There is a point on the string that does not move up or down.
D. There are several points on the string that do not move up or down.
E. All of the above.

QUESTION 2 [28]

2.1 A tortoise and a rabbit engage in a footrace over a distance of 4 km. The rabbit runs 0.5 km and then stops for a 90 minute nap. Upon awakening, he remembers the race and runs twice as fast. Finishing the course in a total time of 1.75 h, the rabbit wins the race.

(a) Calculate the average speed of the rabbit. (2)

(b) Calculate his average speed in $m.s^{-1}$ before he stopped for a nap. (4)

2.2 With the help of equations, define average velocity and instantaneous velocity. (4)

2.3 Two cars which are facing in opposite directions are placed 10 m apart on a long straight track. If both cars start accelerating away from each other at the same time at a constant rate of 2 $m.s^{-2}$, calculate how far apart will the cars will be at the end of 3 s. (6)

2.4 A soccer player kicks a ball horizontally off a 40 m high cliff into a pool of water. If the player hears the sound of the splash 3 s later, calculate the initial speed given to the ball. Assume the speed of sound in air to be 343 $m.s^{-1}$. (8)

2.5 The x-component of a velocity vector that has an angle of 37^0 to the +x-axis has a magnitude of 4.8 $m.s^{-1}$.

(a) Calculate the magnitude of the velocity (2)

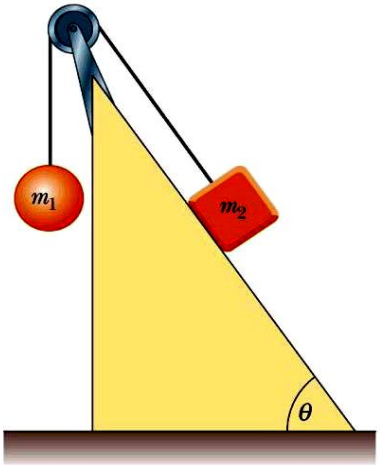
(b) Calculate the magnitude of the y-component of the velocity. (2)

QUESTION 2 [20]

2.1 Here is a story of a horse and a farmer: One day, the farmer attaches a heavy cart to the horse and demands that the horse pull the cart. "Well," says the horse, "I cannot pull the cart, because, according to Newton's third law, if I apply a force to the cart, the cart will apply an equal and opposite force on me. The net result will be that I cannot pull the cart, since all the forces will cancel. Therefore, it is impossible for me to pull this cart." The farmer was very upset. What could he say to persuade the horse to move? (2)

2.2 Two projectiles are thrown with the same initial speed, one at an angle θ with respect to level ground and the other at an angle $90^o - \theta$. Both the projectiles strike the ground at the same distance from the launch point. Were both the projectiles in the air for the same length of time? Make use of the appropriate arguments to discuss your answer. (2)

2.3 Two objects are connected by a light string that passes over a frictionless pulley, as in the figure below. The incline has a coefficient of kinetic friction $\mu = 0.1$ between mass m_2 and the surface, $m_1 = 2$ kg, $m_2 = 7$ kg, and $\theta = 55°$. Draw free-body diagrams of both objects in the box provided and



(a) derive the equation for acceleration of this motion. (4)

Calculate:-

(b) the magnitude of the accelerations of the objects, (2)

(c) the tension in the string, (2)

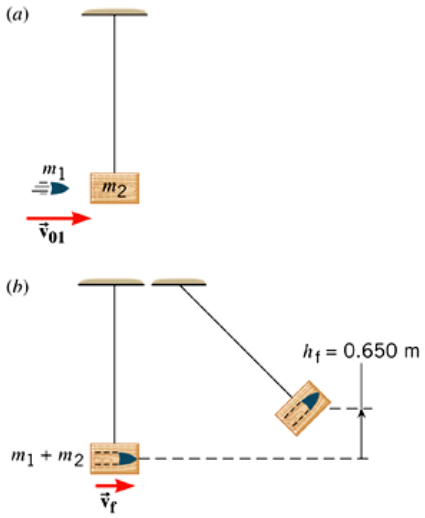
(d) the kinetic energy of the system after 4 s. (4)

2.4 A 1500 kg race car can go from 0 to 90 km/h in 5 s. Calculate the power required to do this. (4)

QUESTION 3 [13]

3.1 A stationary object receives a direct hit by another object moving toward it. Is it possible for both objects to be at rest after the collision? Explain your answer. (2)

3.2 The mass of the block of wood is 2.50 kg and the mass of the bullet is 0.0100 kg. The block swings to a maximum height of 0.650 m above the initial position as shown in the figure below. Calculate the initial speed of the bullet. (8)



3.3 The centers of a 4.0 kg sphere and a 7.5 kg sphere are separated by a distance of 1.5 m. With the aid of the diagram calculate the center of mass of the two-sphere system. (3)

QUESTION 4 [29]

4.1 With the aid of diagram(s) and proper scientific explanation, derive the equation for the frequency of vibration, *w*, for a spring undergoing simple harmonic motion. **NB**: You need to show how you got to the equation of displacement as well. (8)

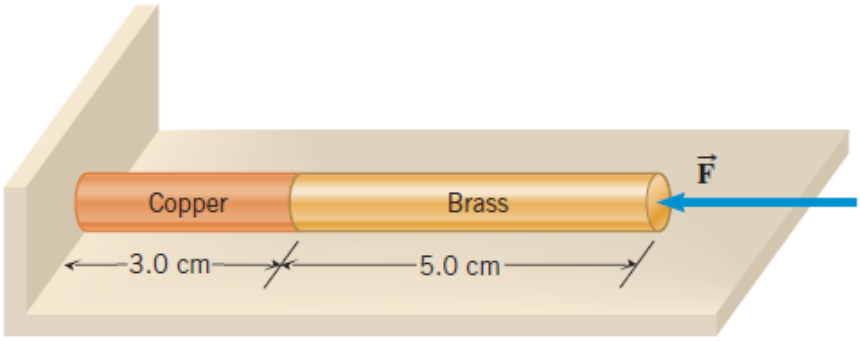
4.2 A person who weighs 670 N steps onto a spring scale in the bathroom, and the spring compresses by 0.79 cm.

(a) Calculate the spring constant. (2)

(b) Calculate the weight of another person who compresses the spring by 0.34 cm. (3)

4.2 With the aid of diagrams, define and distinguish between simple harmonic motion and damped harmonic motion. (4)

4.3 A copper cylinder and a brass cylinder are stacked end to end, as in the drawing. Each cylinder has a radius of 0.25 cm. A compressive force of F = 6500 N is applied to the right end of the brass cylinder. Calculate the amount by which the length of the stack decreases. (5)



4.3 State and define two types of mechanical waves. (2)

4.4 From a vantage point very close to the track at a stock race, you hear the sound emitted by a moving car. You detect a frequency that is 0.75 times small as the frequency emitted by the car when it is stationery. The speed of sound is 343 m/s. Calculate the speed of the car. (5)

HE END