UNIVERSITY OF JOHANNESBURG

**FACULTY OF SCIENCE**
FAKULTEIT NATUURWETENSKAPPE

**DEPARTMENT OF PHYSICS**
**DEPARTEMENT FISIKA**
**(APK)**

**MODULE:** PHYS0A1/S1A1: Physics Major

# June Assessment

**DATE: June 2020**

**EXAMINER:** **Mr. P. Molefe**
**Ms. S.P Xhakaza**
**Mr. D. Unwuchola**

**MODERATOR:** **Prof. B.P Doyle**

**TIME:** 150 minutes
**MARKS:** 100

| **Question** | | **Mark** |
|---|---|---|
| 1 | 30 | |
| 2 | 10 | |
| 3 | 45 | |
| 4 | 15 | |
| **Total** | **100** | |

**INSTRUCTIONS:**
This test consist of multiple choice questions, true/false, and long questions. In some questions, you are expected to work them out before choosing the correct answer. Questions are randomised for each student. Answer all questions. You are required to use a scientific calculator. Once the started, test **must be completed in one sitting**. The test consist of **two sections A and B**, section A is timed for **120 minutes** and section B is timed for **30 minutes + 20 minutes** to upload long questions after the test. You will see the timer before you begin the test. The test will present one question at a time. You are not allowed to go back to questions you have already answered. **Please save each answer (not submit)** continue to the next one and when you have completed the test **save and submit**. Results will be shown to you after everyone has completed the test. **For your long questions SECTON B you need to indicate your SURNAME, INITIALS and STUDENT NUMBER at the TOP-RIGHT OF EACH PAGE.** Failure to do so, we will not mark your answers resulting in a **0/15**. NB: This section you must SCAN AND SUBMIT both questions in one file.

NB: Email the three of us in one email:

pmolefe@uj.ac.za;sxhakaza@uj.ac.za and doomnullu@uj.ac.za, **THIS WILL HELP YOU TO GET THE QUICKEST RESPONSE WHEN YOU NEED HELP DURING THE EXAM.**

# SECTION A

## QUESTION 1 [30]

1.1 In which one of the following situations is zero net work done? **[2]**

a. A ball rolls down an inclined plane.
b. A physics student stretches a spring.
c. A projectile falls toward the surface of Earth.
d. A box is pulled across a rough floor at constant velocity.
e. A child pulls a toy across a rough surface causing it to accelerate.

1.2 The component of acceleration of a particle parallel to the instantaneous velocity of the particle is referred to as the … **[2]**

a. centripetal acceleration
b. instantaneous acceleration
c. radial acceleration
d. tangential acceleration
e. relative acceleration

1.3 The acceleration due to gravity of an object on the Earth's surface **[2]**

a. is a universal constant, like $G$;
b. does not depend on the Earth's mass;
c. is directly proportional to the Earth's radius;
d. does not depend on the object's mass.
e. none of the preceding

1.4 The center of mass of an object **[2]**

a. always lies at the center of the object,
b. is at the location of the most massive particle in the object,
c. always lies within the object,
d. always lies outside the object,
e. none of the preceding.

1.5 Beats are the direct result of **[2]**

a. interference,
b. refraction,
c. diffraction,
d. the Doppler effect,
e. all of the preceding

1.6 Which one of the following is characteristic of an *inelastic collision*? **[2]**

a. Total mass is not conserved.
b. Total energy is not conserved.
c. Linear momentum is not conserved.
d. Kinetic energy is not conserved.
e. The change in momentum is less than the total impulse.

1.7 When a constant force acts on an object, what does the object's change in momentum depend upon? **[2]**

a. The change in momentum depends upon the mass of the object.
b. The change in momentum depends upon the time interval during which the force acts.
c. The change in momentum depends upon the change in the velocity of the object.
d. The change in momentum depends upon the magnitude of the force.
e. All of the above

1.8 A shell explodes into two fragments, one fragment 25 times heavier than the other. If any gas from the explosion has negligible mass, then… **[2]**

a. the kinetic energy change of the lighter fragment is 25 times as great as the kinetic energy change of the heavier fragment.
b. the momentum change of the lighter fragment is 25 times as great as the momentum change of the heavier fragment.
c. the momentum change of the lighter fragment is exactly the same as the momentum change of the heavier fragment.
d. the kinetic energy change of the heavier fragment is 25 times as great as the kinetic energy change of the lighter fragment.
e. the momentum change of the heavier fragment is 25 times as great as the momentum change of the lighter fragment.

1.9 An object is at rest on a table-top. Earth pulls downward on this object with a force equal in magnitude to *mg*. If this force serves as the action force, what is the reaction force in the action–reaction pair? **[2]**

a. the table pushing up on the object
b. the table pushing down on Earth
c. the object pulling upward on Earth
d. Earth pushing upward on the table
e. the object pushing down on the table

1.10 A player kicks a rugby ball in a high arc toward the opponent's goal. When the soccer ball reaches its maximum height, how does its speed at this point compare to its initial speed? Assume air resistance is negligible. **[2]**

a. The speed at its highest point is equal to its initial speed.
b. The answer cannot be determined unless the angle at which the soccer ball is kicked is known.
c. The speed at its highest point is less than its initial speed.
d. The speed at its highest point is greater than its initial speed.
e. The speed at its highest point is zero.

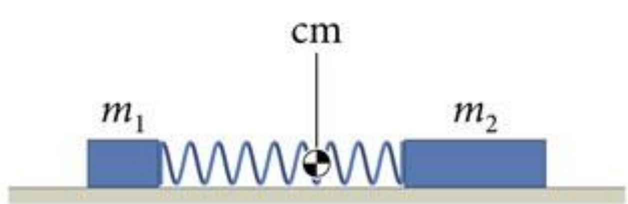
1.11 The two rotating systems shown in the figure differ only in that the two identical movable masses are positioned at different distances from the axis of rotation. If you release the hanging blocks simultaneously from rest, and if the ropes do not slip, which block lands first? **[2]**

a. Both blocks land at the same time.
b. The block on the left lands first.
**c.** The block on the right lands first.

1.12 The radius of the earth is *R*. At what distance above the earth's surface will the acceleration of gravity be 4.9 m/s$^2$? **[2]**

*a.* 1.4*R*
*b.* 0.50*R*
*c.* 1.0*R*
*d.* 2.0*R*
e. 0.41*R*

1.13 Two blocks, of masses $m_1$ and $m_2$, are placed on a horizontal surface and attached to opposite ends of a spring as shown in the figure below. The blocks are then pushed towards each other to compress the spring. The spring constant for the spring is k. Ignore friction and the mass of the spring. Describe the motion of the center of mass of the system when the blocks are released. **[2]**

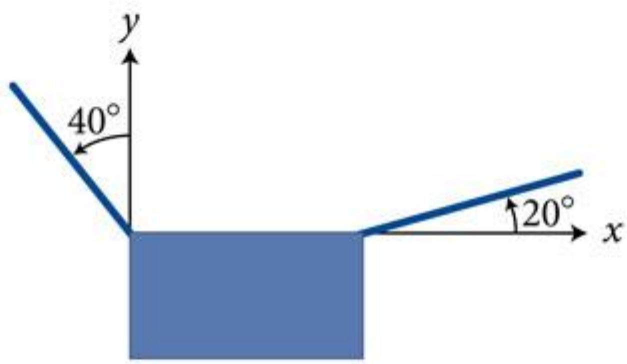



a. The center of mass of the system will not move.
b. The center of mass of the system will move to the left.
c. The center of mass of the system will move to the right

1.14 Sipho and Busi are resting on separate rafts 12 m apart in calm water when Busi notices a small beach toy floating midway between the rafts. Busi and her raft have twice the inertia of Sipho and his raft. The rafts are connected by a rope 14 m long, so she decides to pull on the rope, drawing the rafts together until she can reach the toy. Which raft gets to the toy first? **[2]**

a. Sipho and Busi will reach the toy at the same time.
b. Sipho will reach the toy first.
c. Busi will reach the toy first.

1.15 A sign is suspended by two wires as shown in the figure. Is the tension in each wire larger than, equal to, or smaller than the gravitational force exerted on the sign by Earth? **[2]**




a. The tension in the left wire is smaller than the gravitational force that Earth exerts on the sign. The tension in the right wire is larger than the gravitational force that Earth exerts on the sign.
b. The tension in both wires is larger than the gravitational force exerted on the sign by Earth. The tension in the left wire is equal to the gravitational force that Earth exerts on the sign.
c. The tension in the right wire is smaller than the gravitational force that Earth exerts on the sign.
d. The tension in the left wire is larger than the gravitational force that Earth exerts on the sign. The tension in the right wire is smaller than the gravitational force that Earth exerts on the sign.
e. The tension in both wires is equal to the gravitational force exerted on the sign by Earth.
f. The tension in the left wire is smaller than the gravitational force that Earth exerts on the sign. The tension in the right wire is equal to the gravitational force that Earth exerts on the sign

## QUESTION 2 [10]

2.1 If the acceleration of an object is negative, the object must be slowing down. True/False **[1]**

2.2 If an object is at rest, there must be no forces acting on it. True/False **[1]**

2.3 If $\vec{A} - \vec{B} = 0$, then the vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes and are directed in the opposite directions from each other. True/False **[1]**

2.4 The change in gravitational potential energy can be found by calculating $mg\Delta h$ and subtracting the reference point potential energy. True/False. **[1]**

2.5 Internal forces do not affect the conservation of momentum because they cancel each other out. True/False **[1]**

2.6 If a wheel rotates about a rigid axis through its center, all points on the wheel travel the same distance. True/False **[1]**

2.7 Imagine yourself standing on the edge of an operating merry-go-round. Your tangential speed decreases as you walk toward the center. True/False **[1]**

2.8 Suppose Koos in your physics class says that it is possible for a rigid body to have translational motion and rotational motion at the same time. His statement is… True/False **[1]**

2.9 Bernoulli’s equation is based primarily on the conservation of energy. True/False **[1]**

2.10 A bowling ball rolls without slipping on a flat surface. The ball has both translational and rotational kinetic energy. True/False **[1]**

## QUESTION 3 [45]

3.1 The velocity of an object is given by the expression $v(t)$ = 3.00 m/s + (4.00 m/s$^3$)$t^2$, where $t$ is in seconds. Determine the position of the object as a function of time if it is located at $x$ = 1.00 m at time $t$ = 0.000 s. **[3]**

a. 1.33 m
b. 1.0 m + (3.00 m/s)$t$ + (1.33 m/s$^3$)$t^3$
c. (3.00 m/s)$t$ + (1.33 m/s3)$t^3$
d. (4.00 m/s)$t$ + 1.00 m
*e.* (4.00 m/s)$t$

3.2 An object starts from rest at time t = 0.00 s and moves in the +x direction with constant acceleration. The object travels 12.0 m from time t = 1.00 s to time t = 2.00 s. Calculate the acceleration of the object. **[3]**

a. -12.0 m/s$^2$
b. -4.00 m/s$^2$
c. 8.00 m/s$^2$
d. 4.00 m/s$^2$
e. 24.0 m/s$^2$

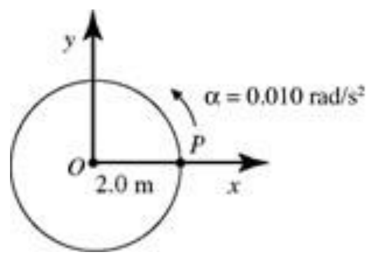
3.3 You roll a 250g wooden croquet ball towards a 0.050 kg golf ball at rest. The wooden ball travels at $v_i$ before the impact with the golf ball and then at 4.0 m/s after the impact. Calculate the speed of the golf ball after impact. Is the collision elastic? **[3]**

a. No, it's totally inelastic.
b. No, it's inelastic
c. Yes, it's elastic.

3.4 The potential energy of an interaction is given by U (x) = $ax^2$, where a = +6.4 J/$m^2$. The initial speed of a 0.88 kg object in this system is 2.53 m/s at x = 0. Calculate how far does the object travel before it reaches a speed of v = 0. Does your answer depend on whether the object is traveling in the positive or negative x direction? **[3]**

a. Yes, the answer in the previous part is for the object traveling in the negative x direction, the distance for the object traveling in the positive xx direction is greater than the obtained result.
b. No, it does not depend on whether the object is traveling in the positive or negative x direction.
c. Yes, the answer in the previous part is for the object traveling in the positive x direction, the distance for the object traveling in the negative xx direction is greater than the obtained result.

3.5 In the figure, point *P* is at rest when it is on the *x*-axis. The time *t*, when *P* returns to the original position on the *x*-axis, is closest to… **[3]**

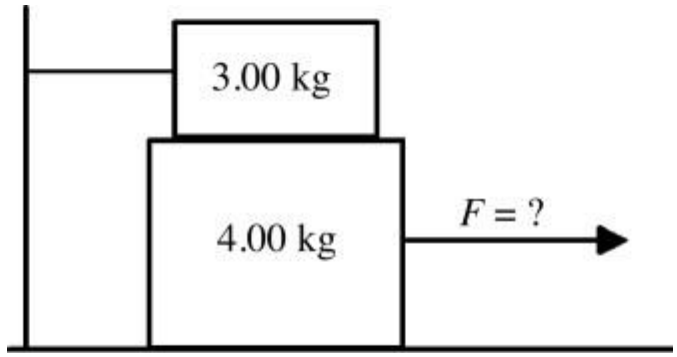



a. 50 s
b. 35 s
c. 18 s
d. 13 s
e. 25 s

3.6 A transverse wave is traveling on a string stretched along the horizontal *x*-axis. The equation for the vertical displacement *y* of the string is given by $y = 0.0020 \cos[\pi(15x - 52t)]$, where all quantities are in SI units. The maximum speed of a particle of the string is closest to… **[3]**

a. 0.53 m/s.
b. 0.43 m/s.
c. 0.74 m/s.
d. 0.64 m/s.
e. 0.33 m/s.

3.7 A 4.00 kg block rests between the floor and a 3.00 kg block as shown in the figure. The 3.00 kg block is tied to a wall by a horizontal rope. If the coefficient of static friction is 0.800 between the two blocks and 0.800 between the block and the floor, what horizontal force *F* must be applied to the 4.00 kg block to make it move? **[3]**

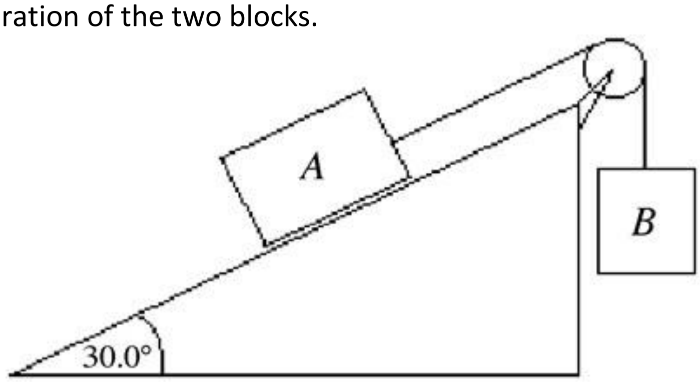



a. 78.4 N
b. 54.9 N
c. 16.2 N
d. 21.1 N
e. 23.5 N

3.8 The work performed as a function of time for a process is given by $W = qt^3$, where $q = 2.4$ J/s$^2$. Calculate the instantaneous power output at $t = 3.7$s. **[3]**

a. 69 W
b. 99 W
c. 208 W
d. 139 W

3.9 Building blocks A and B are connected by a string that goes over an ideal pulley as shown in the figure. Building block *A* has a mass of 3.00 kg and can slide over a rough plane inclined 30.0° to the horizontal. The coefficient of kinetic friction between building block *A* and the plane is 0.400. Building block *B* has a mass of 2.77 kg. Calculate the acceleration of the two blocks. **[3]**




a. 5.35 m/s$^2$
b. 1.96 m/s$^2$
c. 3.12 m/s$^2$
d. 0.392 m/s$^2$
e. 0.0 m/s$^2$

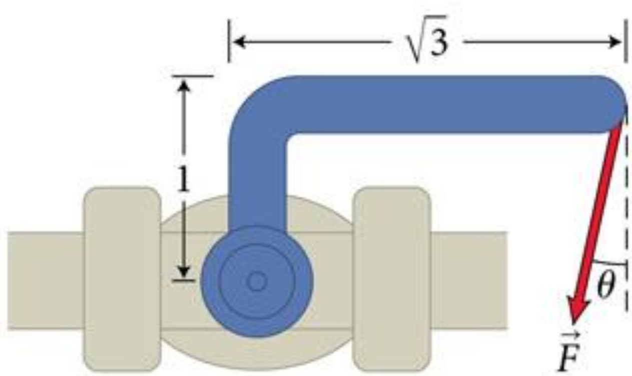
3.10 A 200 g hockey puck is launched up a metal ramp that is inclined at a 30° angle. The coefficients of static and kinetic friction between the hockey puck and the metal ramp are $\mu_s = 0.40$ and $\mu_k = 0.30$, respectively. The puck's initial speed is 63 m/s. Calculate the vertical height the puck reaches above its starting point. **[3]**

a. 270 m
b. 66 m
c. 200 m
d. 130 m

3.11 An SAA plane flies between two points on the ground that are 500 km apart. The destination is directly north of the origin of the flight. The plane flies with an air speed of 120 m/s. If a constant wind blows at 10.0 m/s due west during the flight, what direction must the plane fly relative to north to arrive at the destination? **[3]**

a. 4.78° east of north
b. 4.78° west of north
c. 4.76° east of north
d. 4.76° west of north
e. 85.2° west of north

3.12 The two arms of the L-shaped handle in the figure below have a length ratio of 1:√3. At what angle θ do you want to pull down on the end of the handle to maximize the torque your force causes? **[3]**

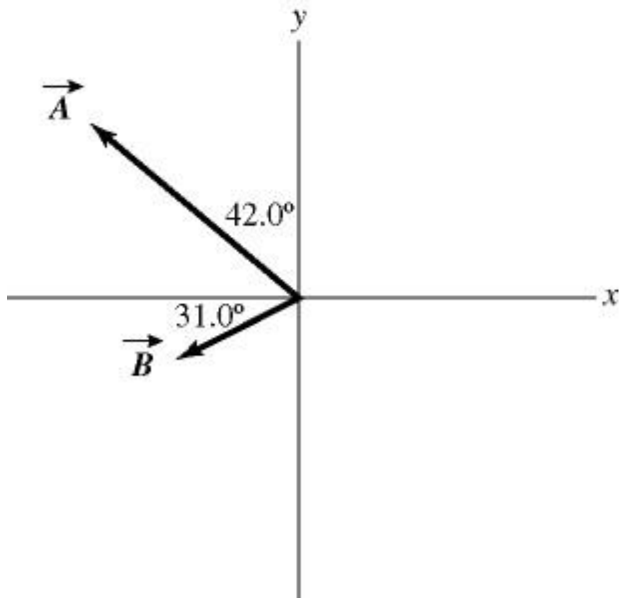



a. 60∘ to the left of the vertical line
b. 45∘ to the right of the vertical line.
c. 30∘ to the left of the vertical line.
d. 45∘ to the left of the vertical line.
e. 30∘ to the right of the vertical line.
f. 60∘ to the right of the vertical line.

3.13 Mr Papa with 60.0 kg of mass drops from rest a distance of 1.20 m to a platform of negligible mass supported by an ideal stiff spring of negligible mass. The platform drops 6.00 cm before Mr Papa comes to rest. What is the spring constant of the spring? **[3]**

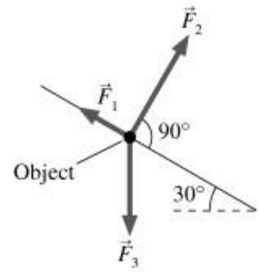
a. $8.83 \times 10^4$ N/m
b. $4.12 \times 10^5$ N/m
c. $2.56 \times 10^5$ N/m
d. $5.45 \times 10^4$ N/m
e. $3.92 \times 10^5$ N/m

3.14 Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = \vec{B} - \vec{A}$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units. What is the angle of vector $\vec{C}$, measured counter clockwise from the +x-axis? **[3]**




a. $22.4^0$
b. $73.1^0$
c. $292^0$
d. $16.19^0$
e. $287^0$

3.15 Three forces are exerted on an object placed on a tilted floor. Forces are vectors. The three forces are directed as shown in the figure below. If the forces have magnitudes $\vec{F}_1 = 1.0$ N, $\vec{F}_2 = 8.0$ N and $\vec{F}_3 = 7.0$ N, where N is the standard unit of force, what is the component of the net force $\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$ parallel to the floor? **[3]**

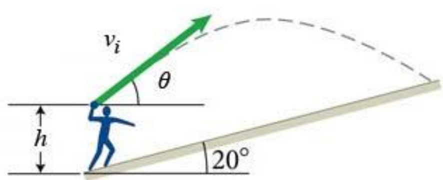



a. 7.8 N
b. 2.5 N
c. 5.1 N
d. 6.0 N

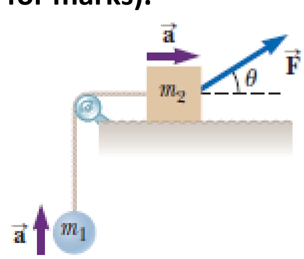
# SECTION B (To be scanned and submitted)

**QUESTION 4 [15]**

4.1 Mosimanegape is standing on a slope of $20^0$ to the horizontal and is going to throw a ball at $v_i$ = 12 m/s up the incline shown in figure. If Mosimanegape throws the ball at θ = 37° with respect to the horizontal, at what distance up the incline from Mosimanegape's feet does it land? Assume the ball leaves Mosimanegape's hand directly overhead, $h$ = 2.3 m above the slope. (**Hint: Draw a clear free-body diagram, it counts for marks.)** **[9]**




4.2 A block of mass $m_2$ on a rough, horizontal surface is connected to a ball of mass $m_1$ by a lightweight cord over a lightweight frictionless pulley as shown in the figure. A force of magnitude $\vec{F}$ at an angle θ with the horizontal is applied to the block as shown, and the block slides to the right. The coefficient of kinetic friction between the block and surface is $\mu_k$. Determine the magnitude of the acceleration of the two objects. (**Hint: Draw a clear free-body diagram, it counts for marks).** **[6]**

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