UNIVERSITY OF JOHANNESBURG

**DEPARTMENT OF PHYSICS (APK)**

**MODULE: PHYSICAL SCIENCES FOR FET 3A**

**CODE: PSFT0A3**

**JUNE EXAMINATION**

**DATE: 07 June 2019**

| | Student's Mark | Question's Mark |
|---|---|---|
| **MCQ** | | 20 |
| **Q 1** | | 12 |
| **Q 2** | | 18 |
| **Q 3** | | 26 |
| **Q 4** | | 24 |
| | | |
| **Total** | | 100 |

## FACULTY OF SCIENCE

EXAMINER/MODERATOR — **Mr. M Khwanda**
**Mr I Phage**

TIME — 3 Hrs

**MARKS** — **100 MARKS**

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**INSTRUCTIONS: ANSWER ALL THE QUESTIONS**

**NUMBER OF PAGES: 8, INCLUDING COVER PAGE**
**REQUIREMENTS: SCIENTIFIC CALCULATOR, NO PROGRAMMABLE CALCULATORS ARE ALLOWED**

**Multiple Choice Questions** **[20]**

1. A bicycle travels 141 m along a circular track of radius 30 m. What is the angular displacement in radians of the bicycle from its starting position?

A) 1.0 rad

B) 1.5 rad

C) 3.0 rad

D) 4.7 rad

E) 9.4 rad

2. Complete the following statement: When a net torque is applied to a rigid object, it always produces a

A) constant acceleration.

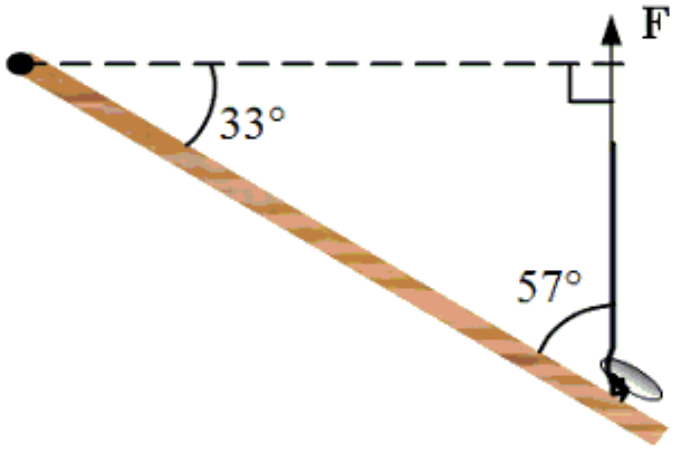
B) rotational equilibrium.

C) constant angular velocity.

D) constant angular momentum.

E) change in angular velocity

3. A string is tied to a doorknob 0.72 m from the hinge as illustrated in the figure. At the instant shown, the force applied to the string is 5.0 N. What is the magnitude of the torque on the door?




A) 2.1 N. m

B) 3.0 N. m

C) 1.0 N. m

D) 0.78 N. m

E) 0.60 N. m

4. Which one of the following statements most accurately describes the *center of gravity* of an object?

A) It is the point where gravity acts on the object.

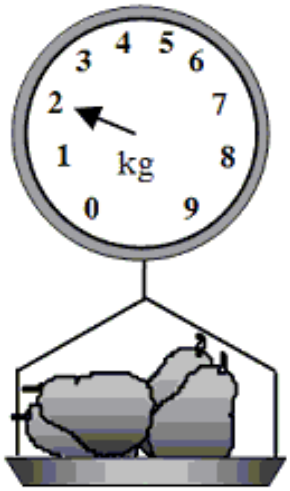
B) It is the point where all the mass is concentrated.

C) It must be experimentally determined for all objects.

D) It is the point on the object where all the weight is concentrated.

E) It is the point from which the torque produced by the weight of the object can be calculated.

5. In the produce section of a supermarket, five pears are placed on a spring scale. The placement of the pears stretches the spring and causes the dial to move from zero to a reading of 2.0 kg. If the spring constant is 450 N/m, what is the displacement of the spring due to the weight of the pears?




A) 0.0044 m

B) 0.0088 m

C) 0.018 m

D) 0.044 m

E) 0.088 m

6. Which one of the following statements is true concerning an object executing simple harmonic motion?

A) The object's velocity is never zero.

B) The object's acceleration is never zero.

C) The object's velocity and acceleration are simultaneously zero.

D) The object's velocity is zero when its acceleration is a maximum.

E) The object's maximum acceleration is equal to its maximum velocity.

7. Complete the following sentence: Resonance occurs in harmonic motion when

A) the system is overdamped.

B) the system is critically damped.

C) the energy in the system is a minimum.

D) the driving frequency is the same as the natural frequency of the system.

E) the energy in the system is proportional to the square of the motion's amplitude.

8. Complete the following statement: Young's modulus cannot be applied to

A) a stretched wire.

B) a compressed rod.

C) a bending beam.

D) a compressed liquid.

E) a stretched rubber band.

9. Complete the following sentence: The operation of a hydraulic jack is an application of

A) Pascal's principle**.**

B) Bernoulli's principle.

C) Archimedes' principle.

D) irrotational flow.

E) the continuity equation.

10. Which one of the following statements concerning a completely enclosed fluid is true?

A) Any change in the applied pressure of the fluid produces a change in pressure that depends on direction.

B) The pressure at all points within the fluid is independent of any pressure applied to it.

C) Any change in applied pressure produces an equal change in pressure at all points within the fluid.

D) An increase in pressure in one part of the fluid results in an equal decrease in pressure in another part.

E) The pressure in the fluid is the same at all points within the fluid.

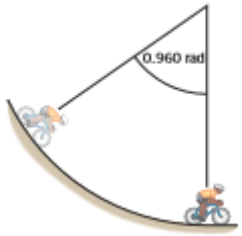
**Question 1: Rotational Kinematics** **[12]**

1.1 Suppose you are driving a car in a counter-clockwise direction on a circular road whose radius is r = 390 m. You look at the speedometer and it reads a steady 32 m/s.

1.1.1 What is the angular speed of the car? (3)

1.1.2) Determine the acceleration (magnitude and direction) of the car (3)

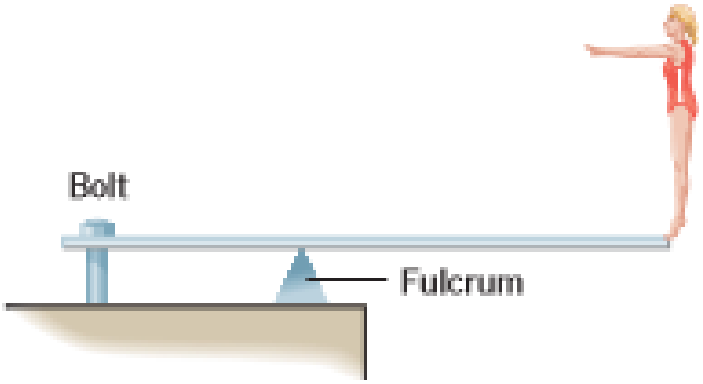
1.2 A bicycle is rolling down a circular portion of a path; this portion of the path has a radius of 9.00 m. As the drawing illustrates, the angular displacement of the bicycle is 0.960 rad. What is the angle (in radians) through which each bicycle wheel (radius = 0.400 m) rotates? (6)



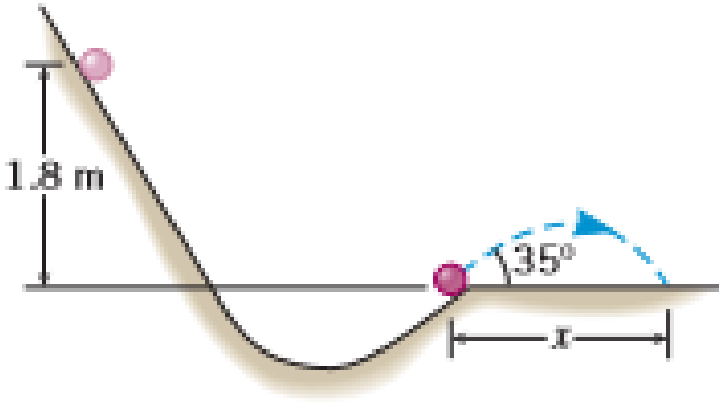

**Question 2: Rotational dynamics** **[18]**

2.1 Explain how will you know if the object is in rigid equilibrium? (2)

2.2 A woman whose weight is 530 N is poised at the right end of a diving board with a length of 3.90 m. The board has negligible weight and is bolted down at the left end, while being supported 1.40 m away by a fulcrum, as shown below. Find the forces $F_1$ and $F_2$ that the bolt and the fulcrum, respectively, exert on the board. (7)




2.3 A tennis ball, starting from rest, rolls down the hill in the drawing. At the end of the hill the ball becomes airborne, leaving at an angle of $35^0$ with respect to the ground. Treat the ball as a thin-walled spherical shell ($I = \frac{2}{3}MR^2$), and determine the range x. (9)



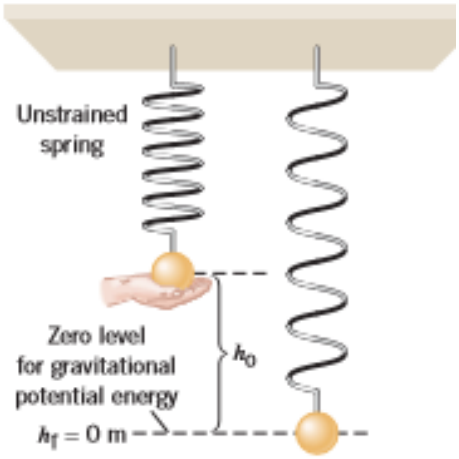

**Question 3: Simple Harmonic Motion** **[26]**

3.1 State Hook's law. (2)

3.2 A helicopter is using a steel cable to lift a 2100 kg jeep. The un stretched length of the cable is 16 m, and its radius is 5.0 x $10^3$ m. Noting that Young's modulus for steel is Y = 2.0 x$10^{11}$ N/$m^2$ and with the aid of a Free Body Diagram, determine the amount the cable stretch when the jeep is hoisted straight upward with an acceleration of +1.5 m/$s^2$? (7)

3.3 A simple pendulum consists of a particle of mass **m** attached to a frictionless pivot by a cable of negligible mass with length ***l***. When the particle is pulled away from its equilibrium position by an angle θ and released, it swings back and forth. With the aid of a *suitable* diagram show that the period of the pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$ (9)

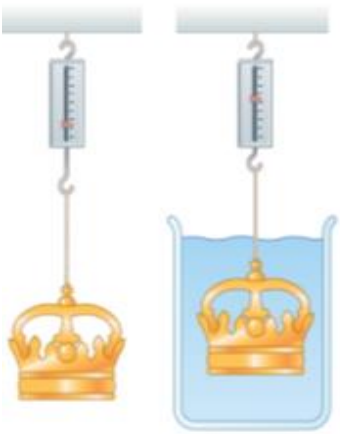
3.4 A 0.20-kg ball is attached to a vertical spring, as on the diagram below. The spring constant of the spring is 28 N/m. The ball, supported initially so that the spring is neither stretched nor compressed, is released from rest. In the absence of air resistance, how far does the ball fall before being brought to a momentary stop by the spring? (8)




**Question 4 : Fluids** **[24]**

4.1 State Archimedes' principle (2)

4.2 Archimedes supposedly was asked to determine whether a crown made for the king consisted of pure gold. According to legend, he solved this problem by weighing the crown first in air and then in water as shown. Suppose the scale read 7.84 N when the crown was in air and 6.84 N when it was in water. What should Archimedes have told the king? (10)



4.3 Using a suitable diagram, derive Bernoulli's equation:

$$P_1 + \tfrac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \tfrac{1}{2}\rho v_2^2 + \rho g y_2$$

(12)

The End