UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF PHYSICS (APK)

MODULE: PHYSICAL SCIENCES FOR FET 3A

CODE: PSFT03A

JULY EXAMINATION

DATE: JULY 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**

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.

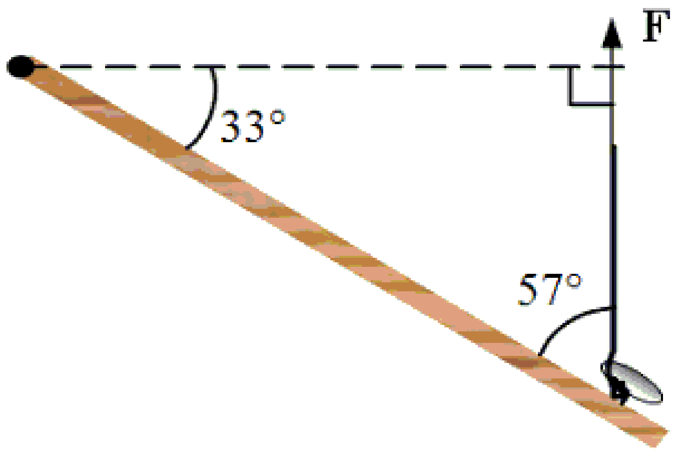
B) rotational equilibrium.

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.

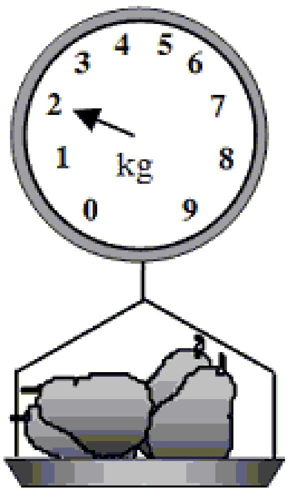
B) It is the point where all the mass is concentrated.

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.

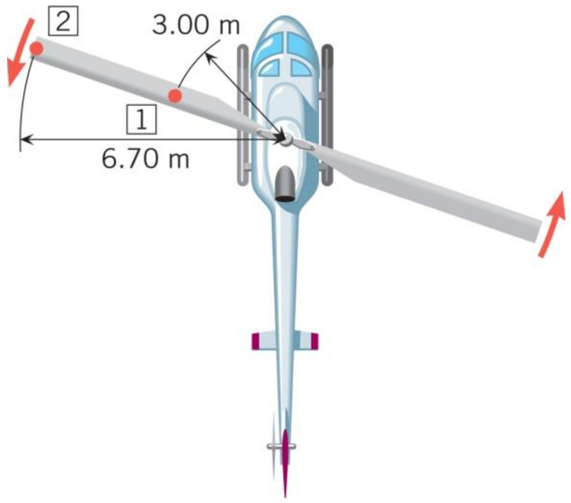
C) Any change in applied pressure produces an equal change in pressure at all points within the fluid.

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 **[12]**

1.1 A helicopter blade has an angular speed of 6.50 rev/s and an angular acceleration of 1.30 rev/s^2.

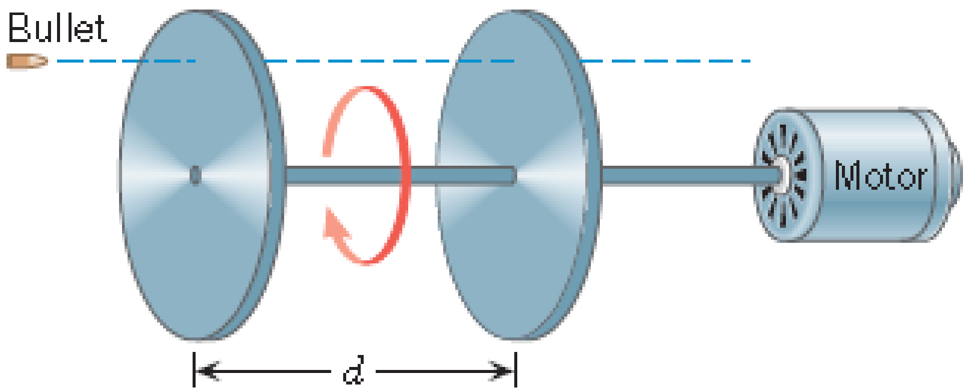


For point 1 on the blade, find the magnitude of

1.1.1 the tangential speed and (3)

1.1.2 the tangential acceleration. (3)

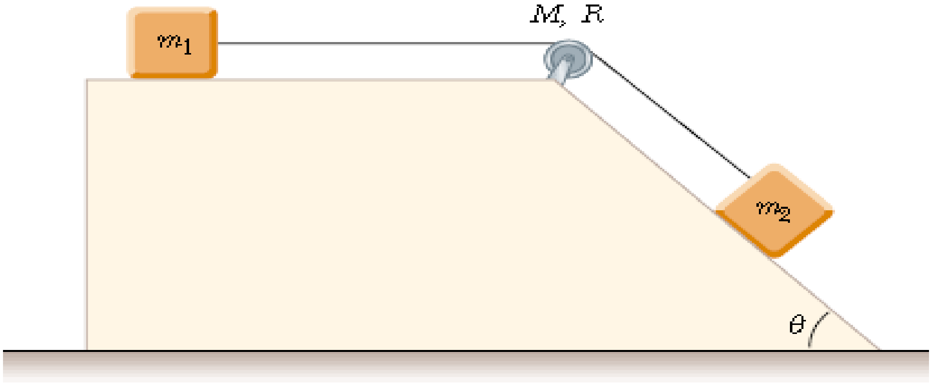
1.2 The drawing shows a device that can be used to measure the speed of a bullet. The device consists of two rotating disks, separated by a distance of d = 0.850 m, and rotating with an angular speed of 95.0 rad/s. The bullet first passes through the left disk and then through the right disk. It is found that the angular displacement between the two bullet holes is θ = 0.240 rad. From these data, determine the speed of the bullet. (6)



Question 2 **[18]**

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

2.2 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. These blocks are allowed to move on a fixed block-wedge of angle θ = 30.0° as shown. The coefficient of kinetic friction is 0.360 for both blocks.



2.2.1 Draw free-body diagrams of both blocks and of the pulley. (6)

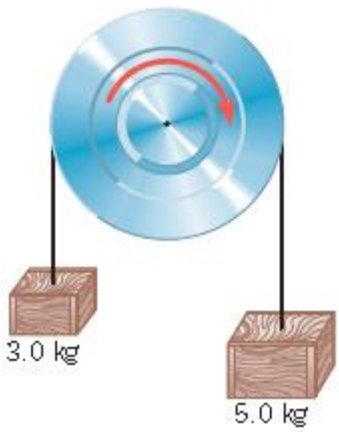
2.2.2 Use the free-body diagram to calculate the acceleration of the two blocks and the tensions in the string on both sides of the pulley. (10)

Question 3 **[26]**

3.1 What is the difference between simple harmonic motion and damped harmonic motion? (2)

3.2 State Hook's law. (2)

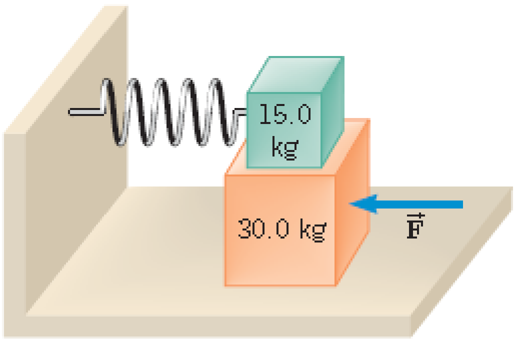
3.3 The drawing shows two crates that are connected by a steel wire (Y= 2.0 x 10^{11} N/m^2) that passes over a pulley. The unstretched length of the wire is 1.5 m, and its cross-sectional area is 1.3x 10^{-5} m^2. The pulley is frictionless and massless. When the crates are accelerating, determine the change in length of the wire. Ignore the mass of the wire. (5)



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. Find the amount by which the length of the stack decreases.

3.4 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)

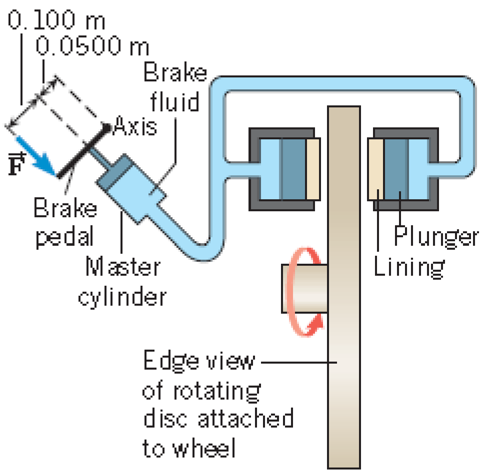
3.5 A 30.0-kg block is resting on a flat horizontal table. On top of this block is resting a 15.0-kg block, to which a horizontal spring is attached, as the drawing illustrates. The spring constant of the spring is 325 N/m. The coefficient of kinetic friction between the lower block and the table is 0.600, and the coefficient of static friction between the two blocks is 0.900. A horizontal force is applied to the lower block as shown. This force is increasing in such a way as to keep the blocks moving at a *constant speed.* At the point where the upper block begins to slip on the lower block, determine the amount by which the spring is compressed and the magnitude of the force. (8)



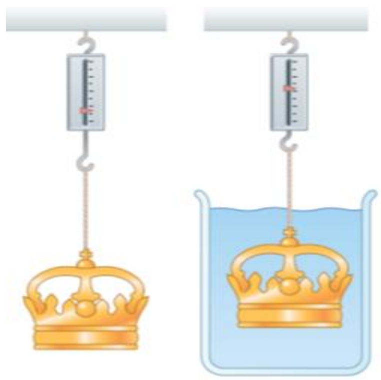
Question 4 **[20]**

4.1 State Pascal's principle (2)

4.2 The drawing shows a hydraulic system used with disc brakes. The force **F** is applied perpendicularly to the brake pedal. The pedal rotates about the axis shown in the drawing and causes a force to be applied perpendicularly to the input piston (radius = 9.50 x 10 $^{-3}$ m) in the master cylinder. The resulting brake fluid to the output plungers (radii = 1.90 x 10 $^{-2}$ m), which are covered with the brake linings. The linings are pressed against both sides of a disc attached to the rotating wheel. Suppose that the magnitude of is 9.00 N. Assume that the input piston and the output plungers are at the same vertical level, and find the force applied to each. (8)



4.3 State Archimedes' Principle. (2)

4.4 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. Use calculations to determine if the gold was fake or not. (10)	

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