

**FINAL**  
Alternative Assessment

(COVER PAGE)

Session : April 2020

Programme : Foundation in Science (CFSI)

Course : PHY1205: Physics 1

Date of Examination : 5 August 2020 (Wednesday)

Time : 9:00am – 1:00pm Reading Time : Nil

Duration : 4 hours

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** questions.

All questions carry equal marks.

Materials permitted :

Non-Programmable Calculator

Materials provided :

Nil

Examiner(s) :

Mr. Dinash Kandasamy

Chief Moderator :

Dr. Beh Boon Choon

*This paper consists of 6 printed pages, including the cover page.*

FOUNDATION IN SCIENCE (CFSI)  
PHY1205: PHYSICS 1  
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

**Instructions:** This paper consists of **FOUR (4)** questions. Answer all questions. All questions carry equal marks.

**Question 1**

- (a) It is said that light from the Sun takes 8.3 minutes to reach the Earth. What is the distance between the Earth and the Sun in miles? [3 marks]
- (b) On average the amount of solar power we get on the Earth is  $1.5 \text{ kW/m}^2$ . How much energy can we get from the Sun in one year? [Given: radius of the Earth is 6378 km] [3 marks]
- (c) Three forces act on an object as follows 200 N [N50°E], 160N [E10°S], 240N [W30°N]. Determine the fourth force which is required to keep the object stationary. [3 marks]
- (d) Given vectors

$$\vec{A} = 4\hat{i} - 3\hat{k}$$

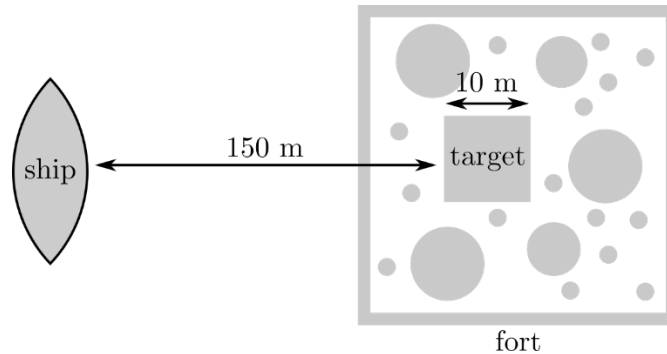
$$\vec{B} = -3\hat{j} + 5\hat{k}$$

Determine

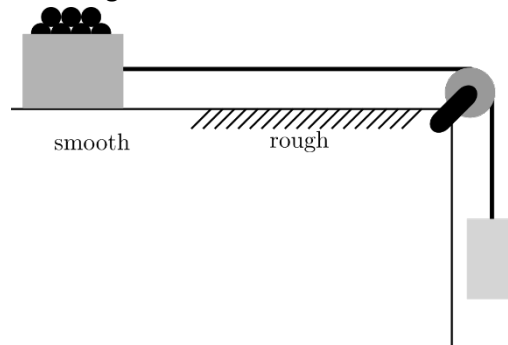
- (i) the angle between  $\vec{A}$  and  $\vec{B}$ . [3 marks]
- (ii) the area of parallelogram formed by  $\vec{A}$  and  $\vec{B}$ . [3 marks]
- (e) During a football match a player receives the ball moving with velocity 12 m/s [E20°N] and deflects it such that it moves with velocity 10m/s [E30°N] towards his teammate standing 90 m away. The ball experiences deceleration,  $a = 1.2 \text{ m/s}^2$  due to its contact with the pitch. The teammate notices the ball will not reach him and starts to run for the ball. If his reaction time is 0.25 s and he is able to accelerate at  $1.6 \text{ /s}^2$  . Note: the ball is always in contact with ground.
- (i) Determine the distance travelled by the ball before it stops. [2 marks]
- (ii) Determine the time taken for the ball to stop. [2 marks]
- (iii) Does the player manage to reach the ball before it stops? Why? [3 marks]
- (iv) Determine the minimum acceleration necessary for the receiver to reach the ball before it stops. [3 marks]
- [Total: 25 marks]

**Question 2**

- (a) A ship is laying siege to a coastal fort they wish to capture. The captain instructs the crew to fire the cannons to neutralize the defenses of the fort without destroying other buildings in the vicinity. The height of the defenses of the fort is 10 m above the cannon's level. The gunner knows that the cannon ball leaves the cannon at 100 m/s. The gunner wishes to target the center of the target and assumes air resistance is negligible.



- (i) What are the possible angles the gunner can aim the cannon to accomplish his task? [4 marks]
- (ii) How long does the cannon ball take to hit the target in each case? [2 marks]
- (iii) The captain wishes to give the occupants of the target enough time to evacuate the structure to reduce loss of lives. Which angle should the gunner aim the cannon at and at what speed would the cannon ball strike the target? [3 marks]
- (b) A pulley system is designed to lower an object of mass 100 kg by connecting it to a 400 kg container filled with rocks using cable as shown in Fig Q2(b). The surface the container slides along transitions from smooth to rough where the rough surface has a coefficient of kinetic friction of 0.25.



- (i) Determine the acceleration and tension in the cable in the smooth section. [4 marks]
- (ii) Determine the acceleration and tension in the cable in the rough section. [4 marks]
- (iii) Determine the amount of mass that needs to be added or removed from the container in the rough section for the system to maintain its acceleration as in the smooth section. [3 marks]

- (c) A ball of mass 500 g is thrown upwards with speed 10 m/s. The ball reaches a maximum height of 4.9 m. Air resistance is not negligible. Determine the
- i. energy lost by the ball, [2 marks]
  - ii. average force due to air resistance on the ball, [1 mark]
  - iii. average acceleration as the ball rises. [2 marks]
- [Total: 25 marks]

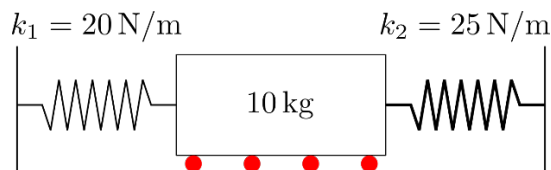
**Question 3**

- (a) A highway engineer needs to determine the speed limit along a stretch of a newly constructed highway. The stretch of road consists of a straight road and a small hill with radius of curvature 40 m.
- (i) Show that the speed limit applies to all vehicles of different masses. [3 marks]
  - (ii) What is the maximum speed vehicles can travel at without any mishaps? [1 marks]
- (b) A turbine is housed inside a pipe of 2 m in diameter and is used to generate electricity from the water following inside the pipe. The turbine is able to convert 50% of the water's kinetic energy into rotational motion and 90% of the rotational motion into electricity. The water flows from a pond 50 m above the turbine's position. It is known that mass flow rate,  $\dot{m}$  is  $100 \times 10^3$  kg/s and the water flows at speed 30 m/s at the bottom (near the turbine). The turbine is rotating at a constant rate of 3600 rpm.
- Determine the
- i. electrical power produced by the system. [2 marks]
  - ii. power loss in the pipes [3 marks]
  - iii. torque acting on turbine due to motion of water  
(Moment of inertia of the turbine, =  $1.5 \times 10^6$  kgm<sup>2</sup>). [3 marks]

- (c) A planet of mass  $6 \times 10^{21}$  kg and radius 6000 km, is orbiting a star with a circular orbit. The planet's gravitational field captures a stationary asteroid of mass  $3 \times 10^{21}$  kg moving at 350 m/s, which is 300 km away from the surface of the planet. The asteroid hits the planet thus increasing its tangential velocity. The planet's tangential velocity just before impact was 300m/s. The asteroid and planet move together at a common velocity after impact. Calculate
- the asteroid's speed just before colliding with the planet, [4 marks]
  - Calculate the collision that produces a maximum common velocity for the asteroid and planet. Explain your assumptions. [3 marks]
- (d) A metal drum with diameter 80 cm and of height 1.5 m. When empty a tenth of the drum is submerged in seawater with density  $1030 \text{ kg/m}^3$ . When completely filled with fluid, seven eighths of the drum is submerged. Determine
- the weight of the drum [2 marks]
  - the weight of the fluid in the drum, [2 marks]
  - density of the fluid assuming the thickness of the drum's wall to be negligible [2 marks]
- [Total: 25 marks]

**Question 4**

- (a) Two cars collide into a stationary car in a series of collisions. First a car moving at 20 m/s collides into the back of another car moving at 18 m/s. Then both the cars are stuck together and collide into the third stationary car. After the second collision all three cars are stuck together. If the cars are identical determine the
- Common speed of the three cars after the second collision. [4 marks]
  - Angular speed of the tires given the diameter of the tires is 60 cm. [1 mark]
- (b) A spring mass system as shown in Fig. 4(b). The system has mass,  $m = 10 \text{ kg}$ , spring constant  $k_1 = 20 \text{ N/m}$  and  $k_2 = 25 \text{ N/m}$ . The mass is displaced 10 cm from the equilibrium position and released. Calculate



(i) the natural frequency of the spring mass system, [4 marks]

(ii) the total energy in the system, [2 marks]

(iii) the speed of the mass at 4 cm from the equilibrium position. [2 marks]

(c) A wave is described by the equation

$$y = 4 \cos(3t - 2x)$$

where x and y are in cm and t is in seconds. Based on the equation determine

(i) wavelength of the wave, [1 mark]

(ii) frequency of the wave, [1 mark]

(iii) speed and direction of the wave, [2 marks]

(iv) maximum speed of particles in the wave. [2 marks]

(d) Explain the process of heat transfer when water is heated over a flame, describe the mechanism and processes that occur to transfer and their equations.

[6 marks]

[Total: 25 marks]

--THE END--