STRATHMORE UNIVERSITY
SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
Bachelor of Science in Electrical and Electronics Engineering
Final Examination
PHY 1101: PHYSICS 1

DATE:12th October 2023 **TIME: 3 hours**

Instruction:

1. **This exam has FIVE questions.**
2. **Answer question 1 (Compulsory) and any two other questions.**

Important constants
Gravitational acceleration $g = 9.8\ m/s^2$

QUESTION 1 (20 MARKS)

a) A particles' velocity in m/s is plotted against time in seconds as shown in Figure 1.

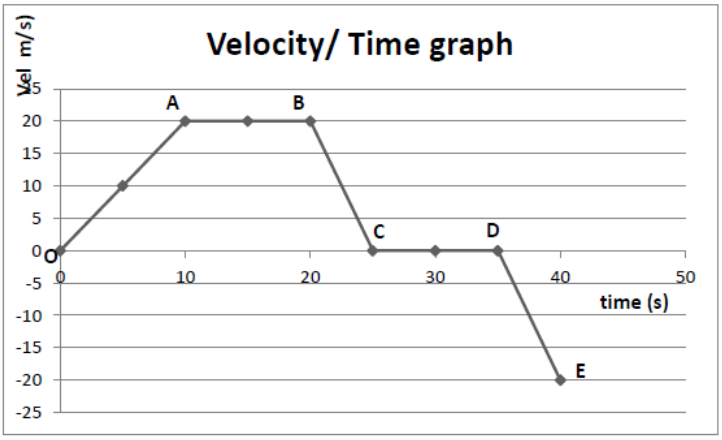

Figure. 1

(i) Describe the particles' motion (2 ½ marks)

(ii) Calculate the total distance covered by the particle (2 ½ marks)

b) A pendulum of length $0.500\ m$ (measured to 1 mm accuracy using a meter rule) takes $28.4\ s$ (measured to $0.1\ s$ accuracy) to complete 20 oscillations. Given that $T = 2\pi\sqrt{\frac{l}{g}}$; where T is the periodic time, l is the length of the pendulum, and g is the gravitational acceleration, find the range of measured values of g. (4 marks)

c) An elevator car has a mass of $1600\ kg$ and is carrying passengers having a combined mass of $200kg$. A constant friction force of $4000N$ retards its motion upward. Calculate the power that the elevators' motor needs to deliver to lift the elevator car at a constant speed of $3.00\ m/s$ (3 marks)

d) A pendulum bob swinging with a simple harmonic motion moves faster when it is at its lowest point. Explain this observation. (2 marks)

e) A particle of mass m rides on a disk of mass $6.0m$ as shown in Figure 2. The disk rotates like a merry-go around about its central axis at an angular speed of $\omega_i = 1.50\ rad/s$. The particle is initially at radius $r = 0.800\ R$, ~~*but*~~ but it moves out to the rim of the disk. Calculate the particles' angular speed (6 marks)

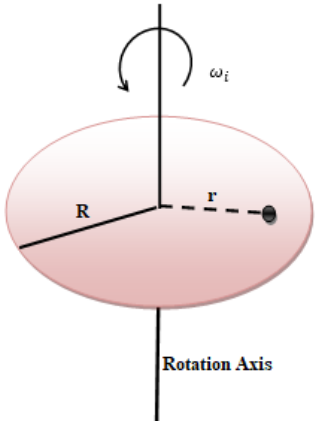

Figure 2

QUESTION 2 (20 MARKS)

a) State the two properties of conservative forces (2 marks)

~~(b)~~b) A 0.3 kg object is moving in a plane with x and y coordinates given by $x = 5t^3 - 1$ and $y = 3t^3 - 2t^2 + 1$, where x and y are in m and t is in s. Find the magnitude and direction of the net force acting on the object at $t = 2.00\ s$ (5 marks)

~~(c)~~c) A traffic light whose weight is 122N hangs from a cable tied to two other cables fastened to a support as shown in Figure 3. The upper cables make angles of 37° and 53° with the horizontal as shown in the figure. These upper cables are not strong as the vertical cable and may break if the tension in them exceeds 100 N. Mathematically find out as to whether the traffic light will remain hanging or any of the cables will break. (8 marks)

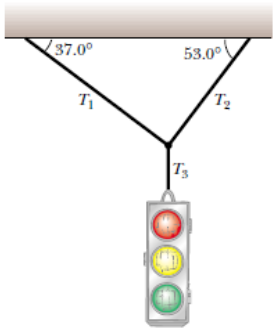

Figure 3

d) A 200-g block connected to a light spring for which the force constant is 5.00 N/m is free to oscillate on a horizontal, frictionless surface. The block is displaced 5.00 cm from equilibrium and released from rest as shown in Figure 4.

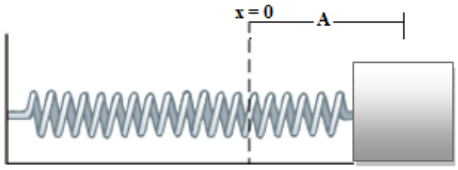

Figure 4

(i) Find the period of its motion (3 marks)

(ii) Determine the maximum speed of the block (2 marks)

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QUESTION 3 (20 MARKS)

a) The innermost track of a compact disk has a radius of 23 mm while the outmost final track has a radius of 58 mm as shown in Figure 5. Suppose the tangential speed of the disk surface at the location of the lens is 1.3 m/s,

Figure 5

(i) Find the angular speed, ω, of the disc when the information is being read from the innermost and on the outmost track (2 marks)

(ii) Given that the maximum playing time of a standard music compact disk is 74 min and 33 s, find the number of revolutions the disk makes during this time? (3 marks)

b) A uniform thin rod of length L and mass M, pivoted at one end is held horizontally and released from rest as shown in Figure 6. Assuming that the effects due to friction and air resistance are negligible,

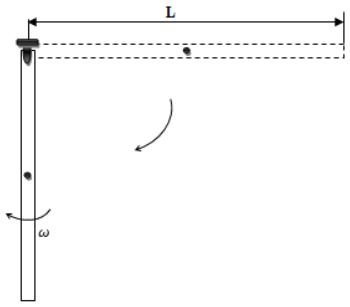

Figure 6

Show that

(i) The moment of inertia is given as $I = \frac{1}{3}mL^2$, (3 marks)

(ii) The final angular speed of the rod as it sweeps through the vertical position is given as $\omega = \sqrt{\frac{3g}{l}}$ (4 marks)

(iii) The force exerted on the rod by the pivot at the instant in (ii) (4 marks)

(iv) The initial speed needed by the rod just to reach a vertical position at the top of the swing (4 marks)

QUESTION 4 (20 MARKS)

a) A proton, A moving along the x-axis with a speed of $3.50 \times 10^5\ m/s^2$ collides with another proton, B, initially at rest. After the collision, proton A moves off at an angle of 37.0^o to the original direction of motion and the B is deflected at an angle of θ along the same axis as shown in Figure 7. Calculate the final speeds of the two protons and angle θ. (14 marks)

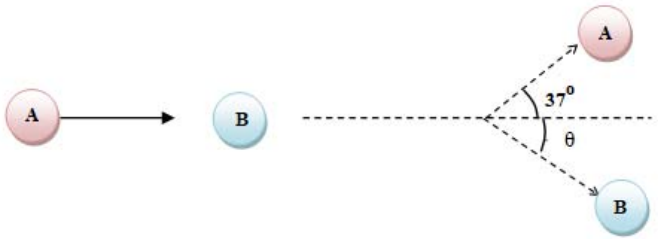

Figure 7: Elastic collision of protons

b) An object of mass 2.00 kg is attached to the hook of a spring balance and the later suspended vertically from the roof of a lift. Calculate the reading on the spring balance when the lift is

(i) Descending with an acceleration of 0.1 m/s^2 (2 marks)

(ii) Ascending with an acceleration of 0.2 m/s^2? (2 marks)

(iii)Moving with uniform velocity? (2 marks)

QUESTION 5 (20 MARKS)

a) A particle takes t seconds to move from x_0 to x. If a force of F_x caused the particles velocity to change from v_0 to v. Show that

(i) $v^2 = {v_0}^2 + 2a_x d$ where $a_x = \frac{v-v_0}{t}$ and $d = x - x_0$ (5 marks)

(ii) Work done $W = F_x d$ (4 marks)

~~(iii)~~b) An object oscillates with simple harmonic motion along the x-axis. Its position varies with time according to the equation $x = (4.00\ m)\cos\left(\pi t + \frac{\pi}{4}\right)$, where t is in seconds and the angles in the brackets are in radians.

(i) Determine the amplitude, frequency, and period of the motion (3 marks)

(ii) Calculate the velocity of the object at time $t = 5\ s$ (4 marks)

(iii) Calculate the acceleration of the object at time $t = 5\ s$ (4 marks)

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