



DIRECTORATE OF MERCHANT SHIPPING GOVERNMENT OF SRI LANKA

CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF
500 GT OR MORE (UNLIMITED)

SUBJECT : APPLIED SCIENCE

DATE : 12.Dec.2023

Time allowed THREE hours

Total marks : 120

Answer any SIX (6) questions

Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required.

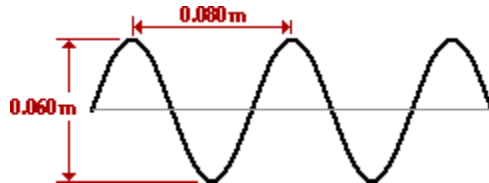
Constants to be use - $g = 9.8ms^{-2}$, $G = 6.67 \times 10^{-11} N m^2kg^{-2}$

1.

- a. A baseball is popped straight up into the air and has a hang-time of 6.25 s. Determine the height to which the ball rises before it reaches its peak. (4 marks)

- b. State Newton's first law (3 marks)

- c. A wave travelling in the positive x direction has a frequency of 25.0 Hz as in the figure below. Find the



- Amplitude
- Wavelength
- Period
- Speed of the wave

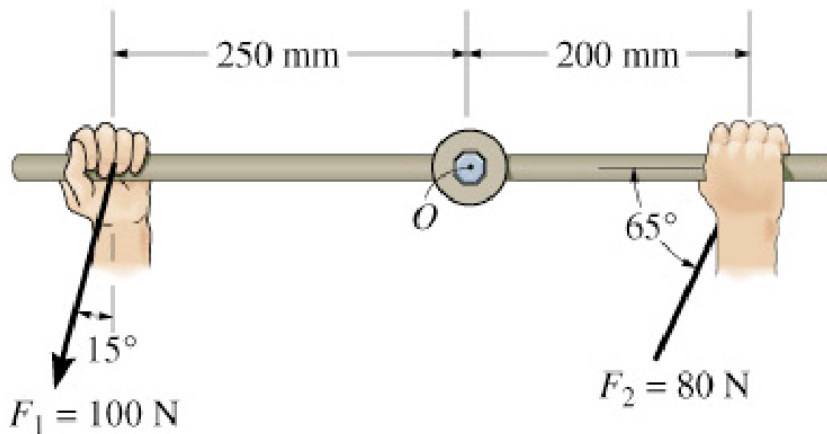
(5 marks)

- d. The focal length of a concave mirror is 3.0 cm. If an object 1.2 cm high stands 4.5 cm from the mirror, determine the characteristics of the image (whether it is real or virtual, upright or inverted) and find:
- the size of the image
 - its distance from the mirror
 - state its characteristics

(8 marks)

2.

- a. Find the kinetic energy of a wheel rotating at 4 rad/s given the mass is 3 kg and the radius of gyration is 0.2 m (4 marks)
- b. A vessel accelerates from a velocity of 1 m/s at a rate of 0.2 m/s² for 30 seconds. Using a velocity - time graph calculates the distance travelled (5 marks)
- c. The wrench is used to loosen the bolt. Determine the moment of each force about the bolt's axis passing through point O.



(4 marks)

- d. What are the general properties of electromagnetic radiation? (3 marks)
- e. If Fe (Iron), Cu (Copper) and Zn (Zinc) metals exposed to electrolyte and electrical contact, explain which metal get corroded.

Galvanic Series

Zn
Fe
Cu

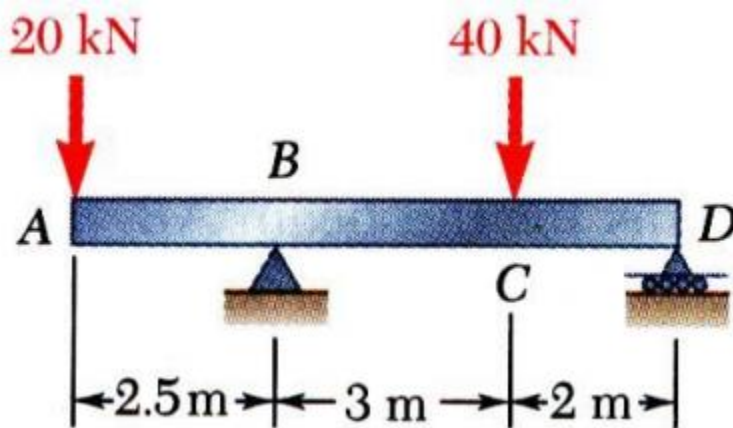
(4 marks)

3.

- a. A 7 kg mass is being pulled towards the right with a rope that has a tension of 70 N at an angle of 42 degrees to the x-axis. If the surface is frictionless, what acceleration will the mass develop?

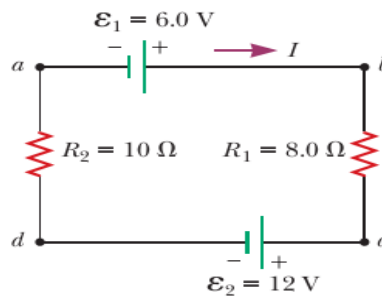
(4 marks)

- b. Draw the shear and bending moment diagrams for the beam shown in the Figure



(8 marks)

- c. Define Humidity (3 marks)
- d. A single-loop circuit contains two resistors and two batteries as shown in Figure (Neglect the internal resistances of the batteries.) Find the current in the circuit.

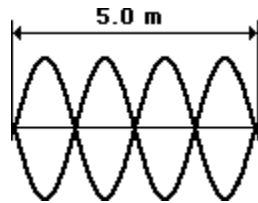


(5 marks)

4.

- a. A student pulls a vacuum cleaner with a force of 40 N at an angle of 28° to the horizontal. The vacuum cleaner moves 2m to the right. Find the work done. (4 marks)
- b. Young's modulus for brass is $8.96 \times 10^{11} \text{ Pa}$. A 120-N weight is attached to an 8-m length of brass wire; find the increase in length. The diameter is 1.5 mm. (4 marks)

- c. The string at the right is 5.0 meters long and is vibrating as the fourth harmonic. The string vibrates up and down with 48 complete vibrational cycles in 20 seconds. Determine the frequency, period, wavelength and speed for this wave.



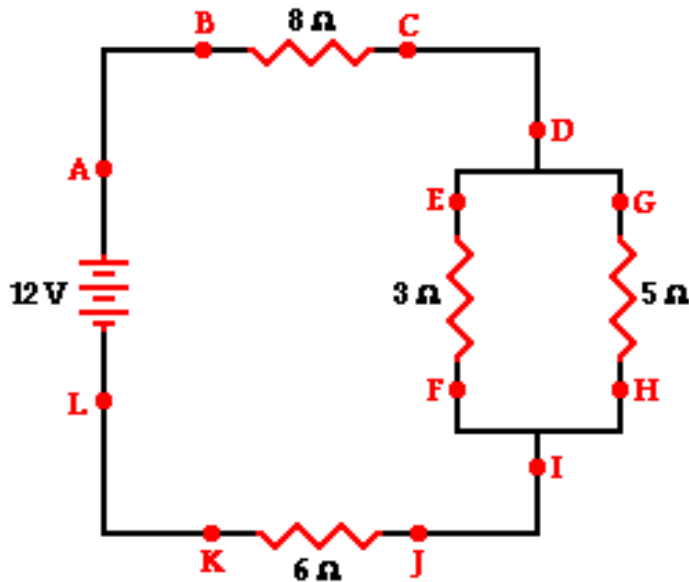
(8 marks)

- d. Briefly explain Earth magnetic Field

(4 marks)

5.

- a. A 5 kg box on a horizontal table is pushed by a horizontal force of 15 N. If the coefficient of friction is 0.4, will the box move? (4 marks)
- b. Find the total resistance, current and power?



(8 marks)

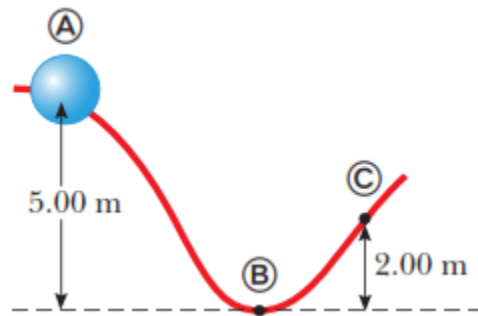
- c. State Newton's Law of Universal Gravitation

(4 marks)

- d. 3 kg of gold at a temperature of 20 °C is placed into contact with 1 kg of copper at a temperature of 80 °C. The specific heat of gold is 130 J/kg °C and the specific heat of copper is 390 J/kg °C. At what temperature do the two substances reach thermal equilibrium? (4 marks)

6.

- a. A 0.400 kg bead slides on a curved wire, starting from rest at point A in Figure. If the wire is frictionless, find the speed of the bead
- at B
 - at C

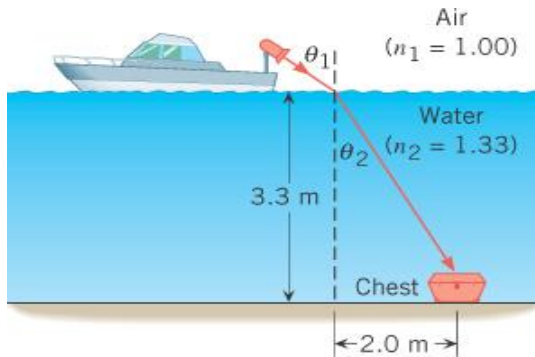


(5 marks)

- b. An SUV with mass 1.80×10^3 kg is traveling eastbound at 15.0 m/s, while a compact car with mass 9.00×10^2 kg is traveling westbound at 15.0 m/s. The cars collide head-on, becoming entangled. Find the speed of the entangled cars after the collision. (4 marks)
- c. A certain machine moves a load of 300 N through a distance of 0.2 m by using an effort of 15 N. If the effort moves through a distance of 5 m. calculate
- The Mechanical Advantage
 - The Velocity Ratio
 - The machine's efficiency

(6 marks)

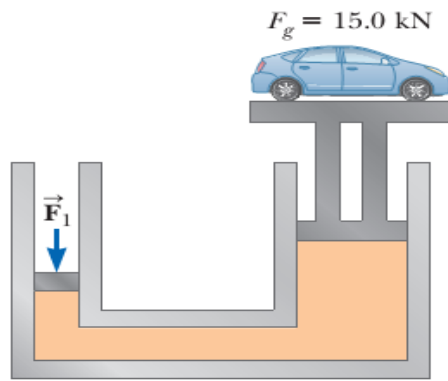
d. Find θ_1 .



(5 marks)

7.

- A Pitot tube is an instrument used to measure airspeed of an aircraft. Calculate the change in pressure read by the instrument if the airspeed is 105 m/s. [Take the density of air at these conditions as 0.95 kg/m^3] (4 marks)
- 6.2 liters of an ideal gas are contained at 3.0 atm and 37°C . How many moles of this gas are present? ($R = 0.082 \text{ L atm / mol K}$) (4 marks)
- John went to pick up his kid at the school. He was traveling about 20 m/s when the release bell went off at 350 Hz. What frequency does John hear? (The speed of sound in the air is 343 m/s) (4 marks)
- State Archimedes' principle (4 marks)
- The small piston of a hydraulic lift has a cross-sectional area of 3.00 cm^2 , and its large piston has a cross-sectional area of 200 cm^2 . What downward force of magnitude F_1 must be applied to the small piston for the lift to raise a load whose weight is $F_g = 15.0 \text{ kN}$?



(4 marks)