SIR ARTHUR LEWIS COMMUNITY COLLEGE
SCIENCE, TECHNOLOGY, INNOVATION AND SUSTAINABILITY

2024 – 2025 ACADEMIC YEAR - SEMESTER I
END OF SEMESTER EXAMINATION

COURSE TITLE	**:**	**BASIC MECHANICS AND THERMAL PROPERTIES OF MATTERS**
COURST CODE	**:**	**PHY112**
LECTURER	**:**	**BRANDON SCOTT**
DATE	**:**	**Tuesday 17th December 2024**
TIME	**:**	**9.00 – 11.00 AM**
DURATION	**:**	**2 HRS**
STUDENT ID#	**:**	**…….**

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. Write your student's ID number on all the work you hand in.
2. This paper consist of five (5) questions, ***answer all questions***. Write the solutions on the answer sheet/s graph paper/s provided.
3. Ensure that units are included in all working and final answers where appropriate.
4. The use of a scientific calculator is permitted. ***No graphing calculators are allowed.***
5. A maximum of six (6) decimal places should be reported in working where needed. However, **report all final answers** to an appropriate number of significant figures.
6. All graphs should be drawn with a pencil and labels should be written in pen.
7. Do not use correction fluid.
8. Maximum Score: 50 marks.

DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO

Constants:
Acceleration Due to Gravity (g) = 9.8 ms^{-2}

1. Fig. 1 shows the speed–time graph for a car along a journey.

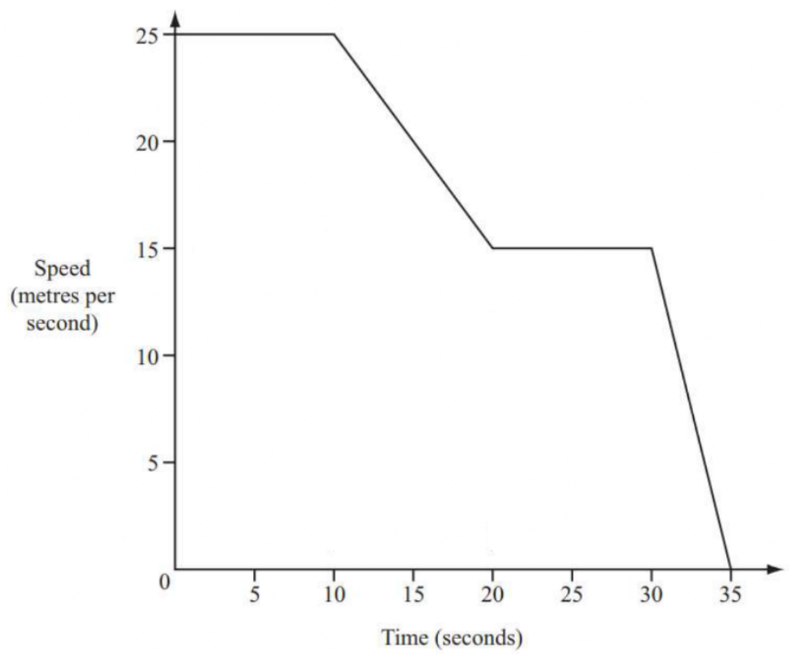


Fig. 1

a. Calculate the acceleration from 10 seconds to 20 seconds. ***(3 marks)***

b. Determine the total distance covered by the car. ***(5 marks)***

c. Based on the speed–time graph of the car, describe its motion for the entire journey. Be sure to indicate key times when the motion of the car changed. ***(2 marks)***

(Total: 10 marks)

2. A heavy piano of mass 400 kg is being hauled up a loading ramp into a moving truck. The ramp makes an angle of 25° with the ground. The piano movers are using a motorized winch that pulls parallel to the ramp's surface. The ramp surface has been covered with smooth wooden rollers to minimize friction.

a. Draw a force diagram showing all forces acting on the piano, with appropriate labels for each force. ***(2 marks)***

b. Determine the minimum tension required in the winch cable to prevent the piano from sliding down the ramp. ***(3 marks)***

c. The loading ramp is 6 m long. If the winch cable were to snap, calculate how much time a mover standing at the bottom of the ramp would have to move to safety before the piano reaches the bottom. ***(3 marks)***

d. Calculate the piano's final velocity when it reaches the bottom of the ramp if the cable breaks. ***(2 marks)***

(Total: 10 marks)

3. A steel wire was originally 1.85 m long with an average diameter of 1.65 mm. The data shown in Table 1 shows the extension (x) and final length when different masses (m) were suspended from it.

Mass / kg	Weight, F / N	Final Length / m	Extension, x / mm
1.0		1.85024	
1.5		1.85036	
2.0		1.85048	
2.5		1.85060	
3.0		1.85072	
3.5		1.85084	
4.0		1.85096	

Table 1

a. Complete the table for F and x. *(2 marks)*

b. PIot a graph of the weight, F against the extension, x, on a graph sheet. Include a line of best fit for the points plotted. ***(4 marks)***

c. Use your graph to calculate the value of Young's Modulus for this metal. ***(4 marks)***

(Total: 10 marks)

4. A motorcycle of mass 320 kg is travelling at 32 ms^{-1} when the rider applies the brakes. The motorcycle has two brake discs each of mass 0.8 kg. The material from which the discs are made has a specific heat capacity of 460 J kg^{-1} K^{-1}.

a. Calculate the kinetic energy of the motorcycle. ***(3 marks)***

b. Calculate the temperature rise of each disc after braking from a speed of 32 ms^{-1}. Assume all the kinetic energy of the motorcycle is converted into internal energy of the brake discs equally during braking. ***(3 marks)***

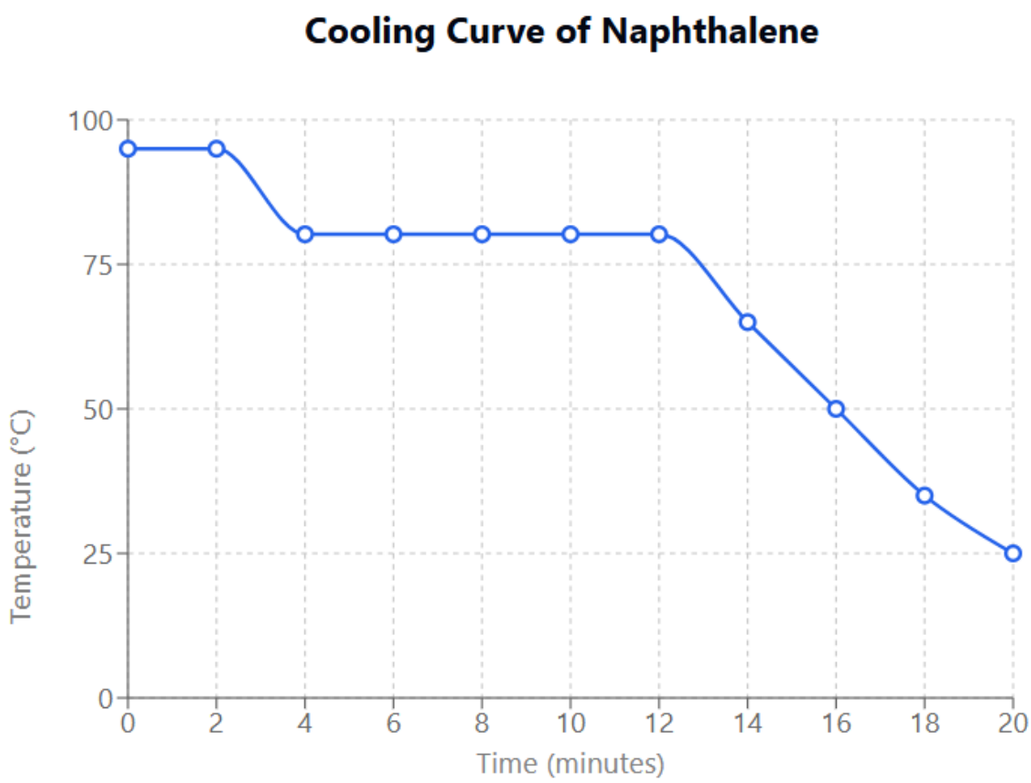
c. State and explain one reason why the actual temperature rise will be different. ***(2 marks)***

d. Suggest one modification to the design of the disc braking system that could reduce the temperature rise of the discs. ***(2 marks)***

(Total: 10 marks)

5. 75 g of melted naphthalene was placed in 250 g of water and the temperature of the naphthalene was recorded over a period of time. The temperature-time graph of the substance shown in Fig. 3 below was obtained:

Fig. 2



a. Why does the temperature remain constant between 4 mins and 12 mins?
(2 marks)

b. Based on the graph, estimate the melting/freezing point of the naphthalene. The temperature does not have to be exact, given the graph does not have subdivisions, but only state one value. ***(1 mark)***

c. At 12 mins, the water's temperature was recorded to be 22°C. The final temperature of the water at 18 mins was 24°C. The specific heat capacity of water is 4200 J kg^{-1} K^{-1}. Calculate the amount of heat energy transferred from the naphthalene to the water. ***(3 marks)***

d. Based on your answer in part (c) and by choosing appropriate temperature values from the graph, calculate the specific heat capacity of the naphthalene. The temperatures do not have to be exact, given the graph does not have subdivisions.
(3 marks)

e. State one (1) source of error or assumption that could drastically affect the results of this experiment, apart from heat being lost to the environment or apparatus.
(1 mark)

(Total: 10 marks)

END OF EXAMINATION