PLMGS
P2

1

Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2020
Secondary 4 Express

CANDIDATE NAME		CLASS		CLASS INDEX NUMBER	
CENTRE NUMBER				INDEX NUMBER	

PHYSICS **6091/02**

Paper 2 **21 August 2020**

Candidates answer on the Question Paper.

No additional materials are required. **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, centre number and index number.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/50
Section B	
11	/10
12	/10
13 E / O	/10
Total	/80

This paper consists of 20 printed pages, including this cover page.

SECTION A (50 marks)

Answer all questions in this section.
Write your answers in the spaces provided.

1 Fig. 1.1 shows the velocity-time graph of a space rocket launched on the surface of a planet. The space rocket starts its engine from rest and rises vertically from the surface of the planet. After several seconds, the engine is switched off.

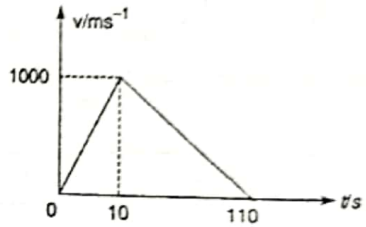

Fig. 1.1

(a) Calculate the maximum height reached by the space rocket.

maximum height = _____ [1]

(b) Calculate the acceleration due to gravity on the planet.

acceleration due to gravity = _____ [1]

(c) Describe the motion of the space rocket from 0 second to 110 seconds.

_____

_____

_____

_____ [2]

2 Fig. 2.1 shows a pendulum suspended by a string that is blown with a wind of a force of 30 N to the right. The mass of the pendulum ball is 2 kg.

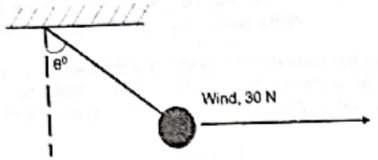

Fig. 2.1

(a) The pendulum is in equilibrium. State the conditions for the pendulum to be in equilibrium.

_____

_____ [1]

(b) Using a scale diagram, determine the tension of the string and the angle θ°.

tension = _____ [2]

θ° = _____ [1]

(c) A student claims that the tension in the string acting on the pendulum is 20 N when the wind is not blowing because the tension and the weight of the pendulum are action-reaction pair. Do you agree with him? Explain your answer.

_____

_____

_____

_____ [2]

[Turn Over

3 Pure gold is usually mixed with copper to form a harder alloy that can be used to make jewellery. Eran bought a gold chain from his best friend, Chai, who claimed that it is rated 21 karats (with 87.5% pure gold). He doubted Chai's claim as the gold chain looked cheap. He went to the school's science laboratory to measure the mass and volume of the chain and obtained 78 g and 5.0 cm^3 respectively.

(a) Suggest an apparatus in the school's science laboratory that can be used to measure the mass accurately.

_____ [1]

(b) Given that the densities of pure gold and pure copper are 19.3 g cm^{-3} and 8.92 g cm^{-3} respectively, calculate the percentage, by mass, of pure gold in the gold chain. Assume the volume and mass of gold and copper remain unchanged during mixing.

percentage = _____ [3]

4 Fig. 4.1 shows a non-uniform plank **XY** 2.50 m long and weighing 900 N. Spring balances A and B are attached to the plank at a distance of 0.40 m from each end, as shown.

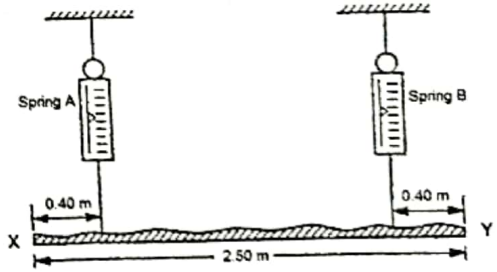

Fig. 4.1

When the plank is horizontal, spring balance B records 580 N.

(a) Define moment of a force.

_____

_____ [1]

(b) Determine the reading on spring balance A.

reading on spring balance A = _____ [1]

(c) Calculate the distance of the centre of gravity from the **X** end of the plank.

distance of the centre of gravity from the **X** end of the plank = _____ [2]

[Turn Over

5 Two barometers are set up as shown in Fig 5.1 below using identical tubes of uniform cross-sectional area, at sea level.

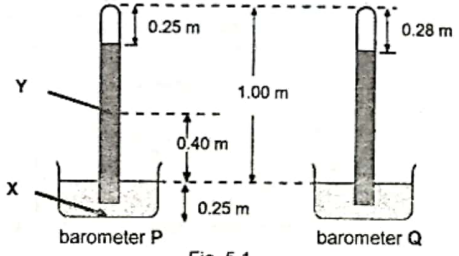

Fig. 5.1

(a) Indicate clearly, in the mercury column for barometer **Q**, with the letter **Z**, the point that has the same pressure as the atmosphere. [1]

(b) Suggest a possible reason why barometer **Q** has a shorter mercury column compared to barometer **P**.

_____

_____ [1]

(c) Calculate the difference in pressure between point **X** and point **Y** in kPa.
(density of mercury = 13 600 kg m^{-3})

difference in pressure = _____ [2]

(d) Suggest a reason for using mercury instead of water in the tubes.

_____

_____ [1]

6 Fig. 6.1 shows the structure of a solar heating system to heat up water in a household.

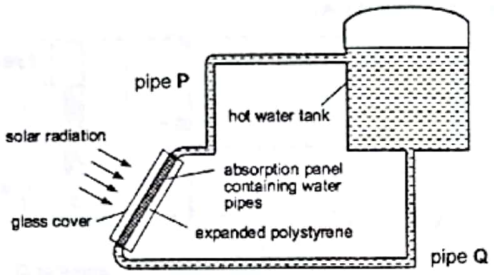

Fig. 6.1

(a) State the process(es) by which heat is transferred from the sun to the water in the pipe through the absorption panel.

_____ [1]

(b) Name the pipe (**P** or **Q**) through which the heated water flows into the water tank. Explain your answer.

_____

_____

_____

_____ [2]

(c) On a hot day, the amount of solar energy falling on the panel is 120 W/m^2. If the total area of the panel is 6 m^2 and only 15% of the energy is absorbed by water, calculate the energy absorbed by the water in 6 hours.

energy = _____ [2]

(d) Suggest an improvement on the panel for better solar energy absorption.

_____ [1]

7 Fig. 7.1 shows a partially inflated balloon placed in a bell jar. The attached vacuum pump is turned on for several minutes. The volume of the balloon increases.

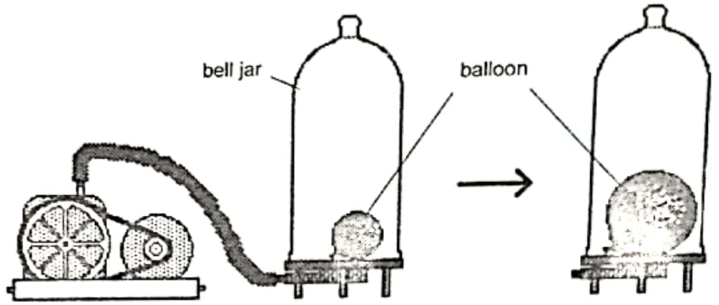

Fig. 7.1

(a) Explain, using the kinetic theory of matter, why the balloon has indefinite shape.

_____

_____

_____

_____ [2]

(b) Before the vacuum pump is turned on, the pressure of the air inside the bell jar is 101 kPa and the balloon contains 80 cm^3 of air. After the pump is turned on, the pressure of the air inside the bell jar is now 45 kPa.

Calculate the volume of air inside the balloon.

volume = _____ [2]

8 Fig. 8.1 shows a narrow laser beam directed towards a point **A** on a vertical wall. A semi-circular glass block **G** is placed symmetrically across the path of the beam.

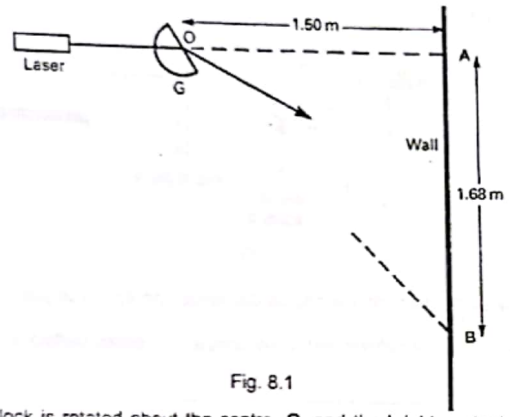

Fig. 8.1

The glass block is rotated about the centre, **O**, and the bright spot where the beam strikes the wall moves down from **A** to **B** and then disappears.

(a) Draw the initial orientation of glass block **G** when the laser is able to strike the wall at **A**, in the diagram below.

[1]

(b) State and explain the direction of rotation (clockwise or anticlockwise) of the glass block **G** in order to obtain the bright spot that moves down from **A** to **B**.

_____

_____

_____ [1]

(c) Explain the disappearance of the bright spot after **B**.

_____

_____

_____ [1]

(d) Calculate the refractive index of the glass block **G**.

refractive index = _____ [3]

(e) Explain whether **AB** would be longer or shorter if the glass block used is of a lower refractive index.

_____

_____

_____

_____ [2]

9 Stars that are being formed emit infra-red radiation. Some of this radiation is received by a telescope that orbits the earth. Microwave signals from the telescope are sent to the Earth surface, as shown in Fig. 9.1.

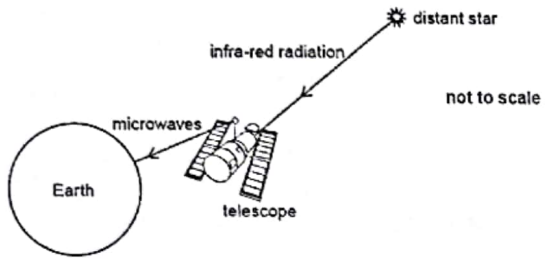

Fig. 9.1

(a) Infra-red and microwave radiation are both part of the electromagnetic spectrum. State one other similarity and one difference between infra-red and microwave radiation.

one similarity : _____

_____

one difference : _____

_____ [2]

(b) The telescope is 1200 km above Earth's surface. Calculate the time for a microwave signal from the telescope to reach the Earth's surface.

time = _____ [1]

(c) Eran claims that he can see Infra-red radiation with his naked eyes, just like Tom Cruise in the movie "Mission Impossible". Do you agree with him? Explain your answer.

_____

_____ [1]

[Turn Over

10 Fig. 10.1 shows a negatively charged metal sphere held with an insulating handle. When the sphere is brought near the metal plate, the sensitive galvanometer indicates a momentary deflection.

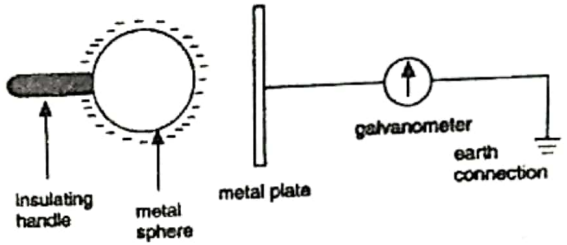

Fig. 10.1

(a) Draw on the diagram, the charge distribution on the metal plate. [1]

(b) Explain why the galvanometer indicates a momentary deflection.

_____

_____

_____

_____ [2]

(c) State and explain whether there is a deflection in the galvanometer if the metal sphere is held by a person's hand.

_____

_____ [1]

(d) Suggest a change in the above setup such that a deflection in the galvanometer in the opposite direction is produced.

_____

_____ [1]

SECTION B (30 marks)

Answer **all** questions in this section.
Answer only one of the two alternative questions in **Question 13**.

11 Fig. 11.1 shows the arrangement used to measure the temperature rise of a piece of lead struck by an air-gun lead pellet.

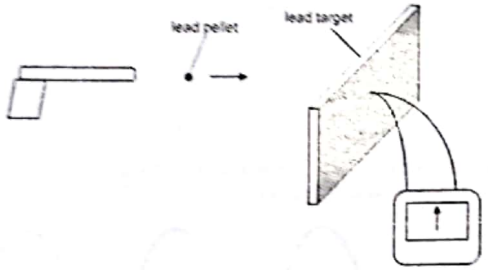

Fig. 11.1

The thermometer consists of a thermocouple whose junction is embedded in the lead. When the temperature of the junction is raised, a deflection is observed on the galvanometer. After the lead pellet is fired into the lead target, the results and data are given below.

Mass of lead target = 39.5 g
Mass of lead pellet = 0.5 g
Deflection on galvanometer = 8 divisions
Specific heat capacity of lead = 130 J / (kg °C)
Galvanometer sensitivity = 10 divisions / °C

(a) Write down the thermometric property of the thermometer and state an assumption on using this property with respect to temperature measurements.

thermometric property : _____

assumption : _____

_____ [2]

(b) Explain what is meant by specific heat capacity of lead is 130 J / (kg °C).

_____

_____ [1]

[Turn Over

(c) **(i)** Determine the temperature rise of the lead target.

temperature rise = _____ [1]

(ii) Hence, calculate the thermal energy gained by the lead target.

thermal energy = _____ [2]

(d) The lead target with the lead pellet embedded, is then detached from the thermometer and immersed into icy water with 20 g of ice and 100 g of water at 25.0 °C. The initial temperature of the lead target and the lead pellet is 40.0 °C.

The specific heat capacity of water is 4200 J / (kg °C).
The specific latent heat of fusion of ice is 3.4×10^5 J / kg.

(i) Assuming all the ice melted in the process, calculate the final temperature of the lead target with the pellet embedded.

final temperature = _____ [3]

(ii) State an assumption you made in the above calculation.

_____

_____ [1]

12 Two students are studying the Physics topics on light and sound waves.

(a) State a similarity between light and sound waves.

_____

_____ [1]

(b) Illustrate by drawing the directions of motions of particles **X**, **Y** and **Z** in Fig. 12.1 and Fig. 12.2 below and explain the differences between light and sound waves. The directions of the waves travelled are as indicated by the arrow.

Light

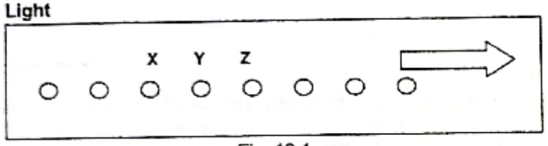

Fig. 12.1

Explanation : _____

_____

Sound

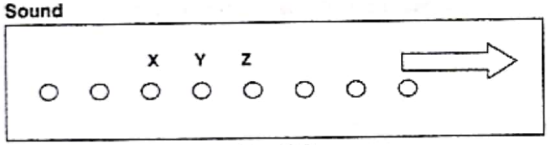

Fig. 12.2

Explanation : _____

_____ [4]

(b) One of the student, using a stopwatch, records a 4.0 seconds delay between seeing a flash of lightning and hearing the sound of the thunder. Calculate the distance between him and the lightning. (Take the velocity of sound in air to be 330 ms^{-1}.)

distance = _____ [2]

(c) The other student, standing beside the first student, hears the softer echo of the thunder reflected from a nearby tall building, another 3.0 seconds later.

(i) Calculate the distance between him and the building. (Take the velocity of sound in air to be 330 ms^{-1}.)

distance = _____ [2]

(ii) On Fig. 12.3, draw the waveform of the echo, given the waveform of the original sound of thunder.

Fig. 12.3 [1]

Either

13E Fig. 13E.1 shows a circuit with a transistor switch used to control the temperature in a room. The transistor switch acts like a switch, when switched on, will activate the relay to turn on the heater in the room. The transistor switch is switched ON when the voltage across the thermistor, V_b, is higher or equal to 2.5 V.

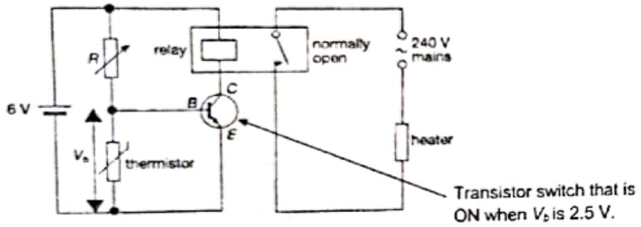

Fig. 13E.1

The relationship between the resistance of the thermistor and the temperature of the surroundings is shown in Fig. 13E.2.

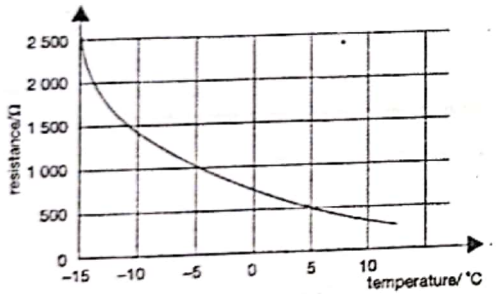

Fig. 13E.2

(a) State what is meant by *resistance*. Write down the SI unit of resistance.

_____ [1]

(b) Describe and explain how the voltage across the thermistor, V_b, changes as the temperature of the surrounding decreases.

_____

_____ [2]

(c) Calculate the voltage across the rheostat, *R*, when the transistor switch just switched on.

voltage = _____ [2]

(d) During a day in winter, the temperature of the surrounding drops below 5 °C.

(i) From Fig. 13E.2, determine the resistance of the thermistor at 5 °C.

resistance = _____ [1]

(ii) Calculate the maximum resistance of the rheostat, *R*, so that the transistor switch can switch ON when the temperature drops below 5 °C.

maximum resistance = _____ [2]

(iii) Calculate the current flowing through the rheostat, *R*, when the temperature drops below 5 °C.

current = _____ [2]

Or

13O (a) Fig. 13O.1 shows the heating element in a heater labelled 240 V, 3 kW.

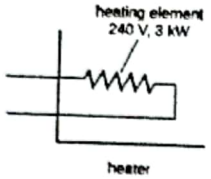

Fig. 13O.1

(i) Explain the label "240 V, 3 kW" on the heating element.

_____

_____ [1]

(ii) Calculate the resistance of the heating element.

resistance = _____ [2]

(iii) The connecting wires of the heating element have a large cross-sectional area.
Explain how this feature helps the connecting wires to remain relatively cool even when the heater has been turned on for a period of time.

_____

_____

_____

_____ [2]

(b) Fig. 13O.2 shows a light aluminium rod AB resting between the poles of a U-shaped magnet, with S pole vertically above rod AB and N pole vertically below rod AB. A current is passed through the rod from the two brass strips connected to a power supply.

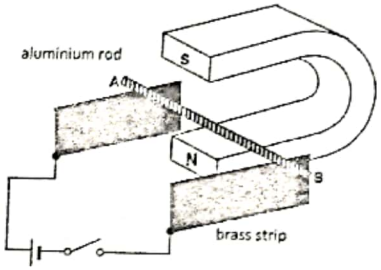

Fig. 13O.2

(i) State and explain which way the rod moves when the switch is closed.

_____

_____

_____

_____ [2]

(ii) State the effect on the movement of the rod when

1. the current is reversed;

_____

_____ [1]

2. the current is decreased;

_____

_____ [1]

3. the magnet is rotated 90° anticlockwise to form an inverted U, with S pole on the left of rod AB and N pole on the right of rod AB.

_____

_____ [1]

END OF PAPER