Name of Candidate: _____ ( ) Class: _____ Calculator Model:

BUKIT PANJANG GOVERNMENT HIGH SCHOOL

PRELIMINARY EXAMINATION 2021

SECONDARY 4 EXPRESS

PHYSICS 6091/02

Paper 2 Theory

Date: 23 Aug 2021
Duration: 1 hr 45 min
Time: 1100 – 1245 h

Candidates answer on the Question Paper.
No additional materials are required

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Write in dark blue or black ink on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use Section A			
1		**5**	
2		**6**	
3		**7**	
4		**8**	

For Examiner's Use	
Section A Total [50]	
Section B Total [30]	
Overall Total [80]	

Setter: Mdm Chee Wei Wei **[Turn over**

Section A (50 marks)

Answer **all** the questions in this section.

1 A motor boat travels due north at a steady speed of 3.0 m/s through calm water in which there is no current as shown in Fig. 1.1.

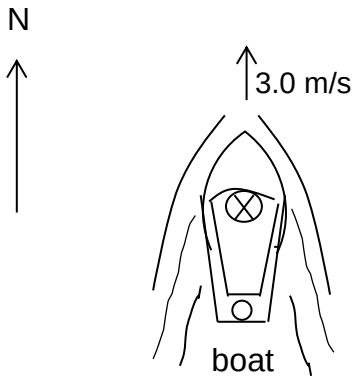


Fig. 1.1

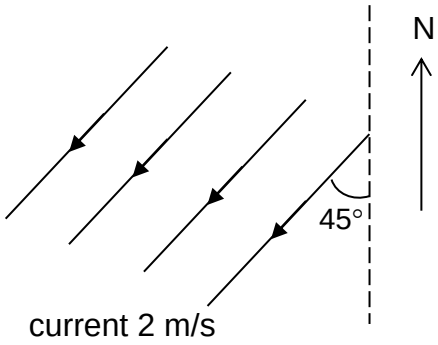


Fig. 1.2

(a) Explain how the first statement gives information not only about the speed of the boat but also about its velocity.

.....

..... [1]

(b) The boat then enters an area of water in which a steady current flows at 2.0 m/s in a south-west direction as shown in Fig. 1.2. Both the engine power of the boat and its course setting remain unchanged.
Draw a vector diagram to determine the magnitude and direction of the resultant velocity of the boat.

magnitude = ……

direction =…… [3]

2 A water wheel has eight buckets equally spaced around its circumference, as illustrated in Fig. 2.1. The distance between the centre of each bucket and the centre of the wheel is 1.6 m. When a bucket is at its highest point, it is filled with 40 kg of water. The wheel rotates and the bucket is emptied at its lowest point.
The gravitational field strength is 10 N/kg.

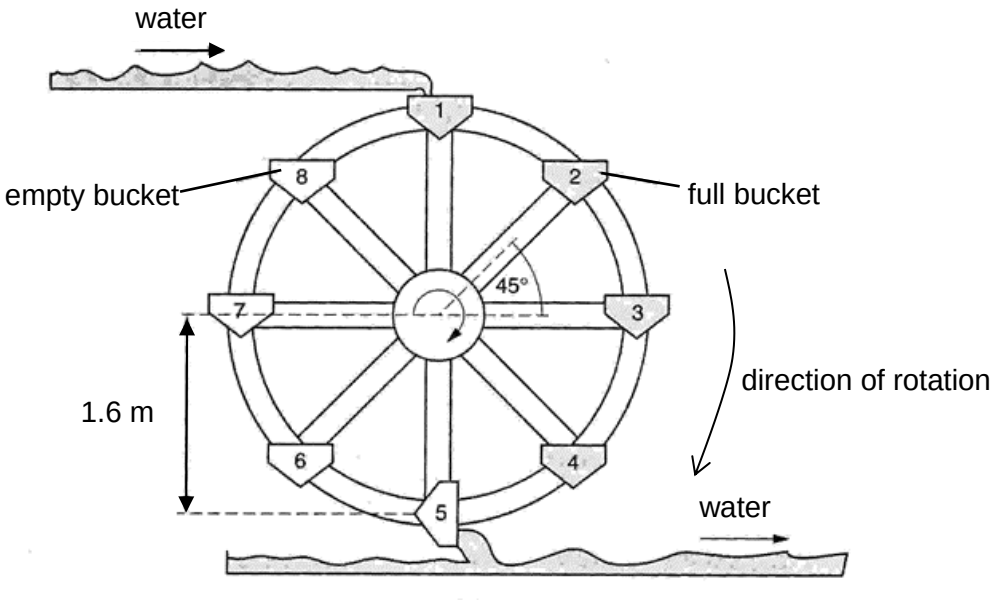


Fig. 2.1

(a) **(i)** Define the *moment of a force*.

……

…… [1]

(ii) Write down the numbers of those buckets containing water that cause a moment about the axle at the instant shown in Fig. 2.1.

buckets: …… [1]

(iii) Determine the largest moment provided by the bucket filled with water about the axle of the wheel.

largest moment = …… [2]

3 Fig. 3.1 shows a liquid-in-glass thermometer.

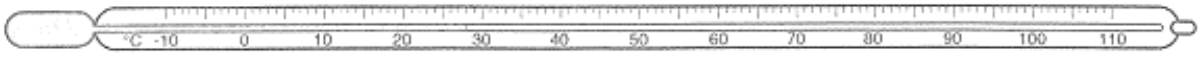


Fig. 3.1

(a) Describe how to check that the upper fixed point is marked correctly on the thermometer.

…….....

…….....

…….....

……..... [2]

(b) The thermometer makes use of the change in volume of a liquid to measure temperature. In the table below, name one other physical property that is used to measure temperature, and the substance or object involved.

	physical property that changes	substance or object involved
example	volume	a liquid

[1]

(c) The thermometer has a heat capacity of 2.5 J /°C and initially reads 20 °C. The thermometer is placed in a small mass of water which is initially at a temperature of 90 °C. The final temperature of the water and the thermometer is 82 °C.
The specific heat capacity of water is 4.2 J / (g°C).

Determine the mass of water.

mass = ……..... [2]

4 The floor of a swimming pool always appears shallower than its actual depth due to the refraction of light. Fig. 4.1 shows the image of a line on the floor of the pool as appeared to the eye looking directly above the surface of the pool.

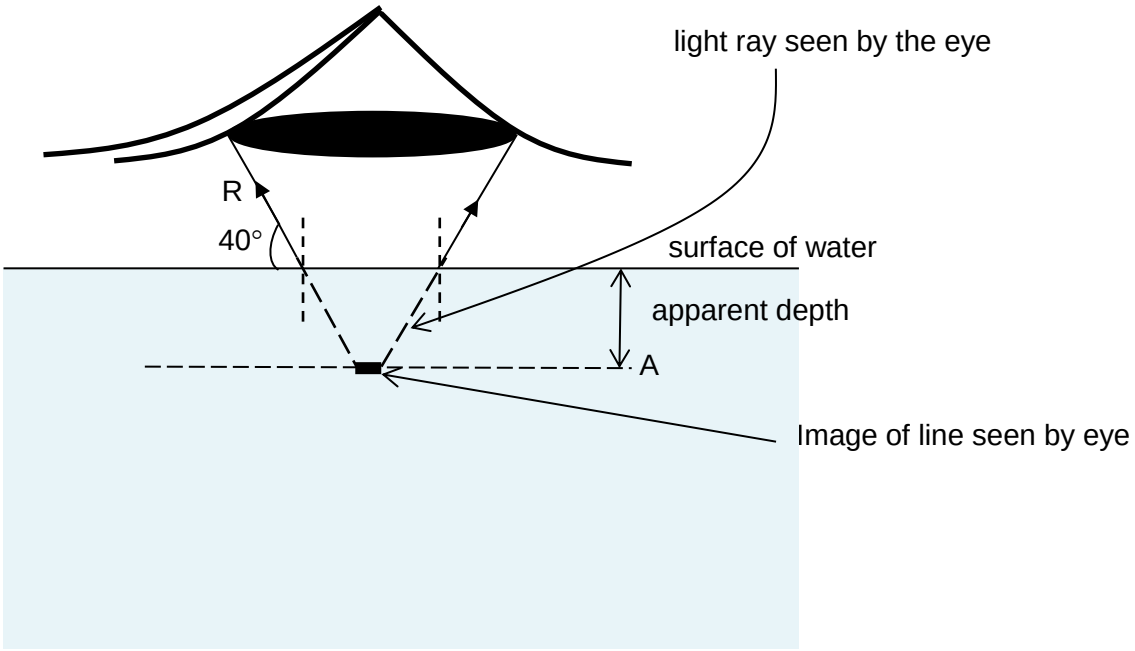


Fig. 4.1 (not drawn to scale)

(a) Complete the ray diagram in Fig. 4.1 to indicate the **actual path** of the light rays from the line on the floor of the pool to the surface of the water. [2]

(**b)** The refracted ray R makes an angle of 40° to the horizontal surface of the pool. Find the angle of incidence of the incident ray directed from the line on the floor of pool to the surface of the water. (refractive index of water = 1.33)

angle of incidence = ……[2]

(c) A layer of oil of refractive index 1.46 is smeared on the surface of the water. Suggest with a reason how the apparent depth of the pool as seen by the eye will be different relative to the original level labelled A in Fig. 4.1.

.....

.....

.....

..... [2]

5 Fig. 5.1 shows a straight dipper vibrating near the water surface of a ripple tank. Water waves forming crests and troughs, are observed as a series of wavefronts moving away from the dipper.

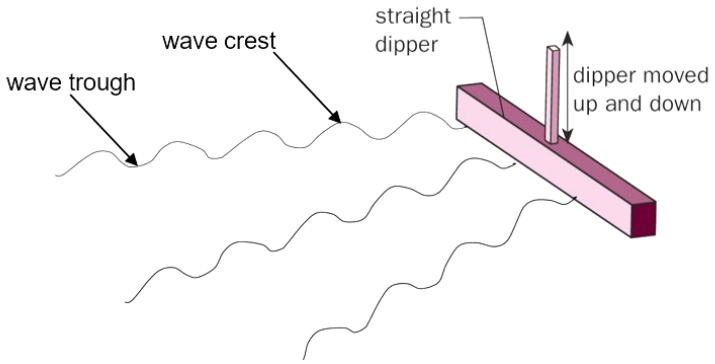


Fig. 5.1

(a) **(i)** Explain what is meant by a *wavefront*.

.....

..... [1]

(ii) Using two dotted lines, draw two consecutive wavefronts in Fig. 5.1. [1]

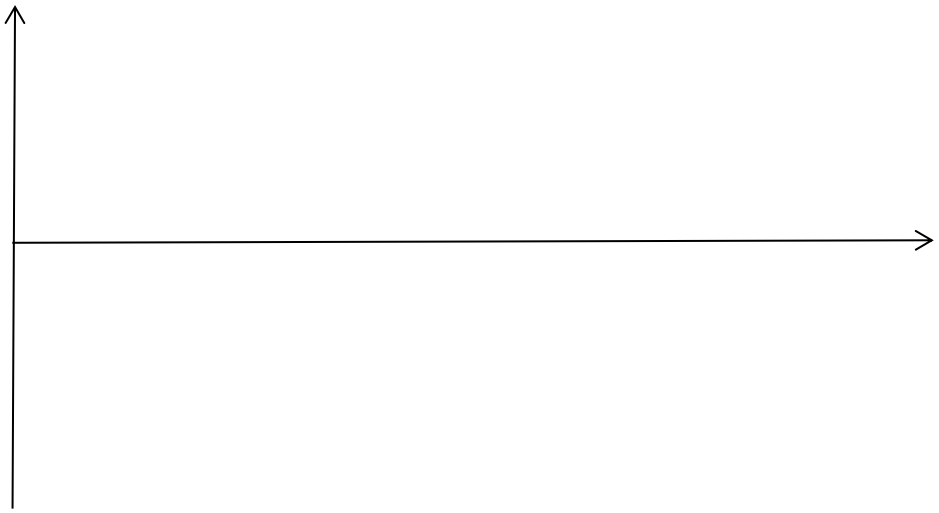
(b) Two students conducting an experiment using the ripple tank to measure the speed of the water waves collected the following readings:

Average number of wave crests passing a point in 10 seconds = 5
Average distance between two consecutive wave crests = 8.0 cm
Average distance from the crest to the trough of the wave = 4.0 cm

(i) Determine the speed of the water wave.

speed = …….. [2]

(ii) Sketch a graph of displacement versus distance of the wave passing through the surface of the water, for a distance equal to twice of its wavelength. Label both axes clearly.



[2]

6 **(a)** Fig. 6.1 and Fig. 6.2 illustrate part of the processes of using static electricity to produce printed documents by a photocopier.

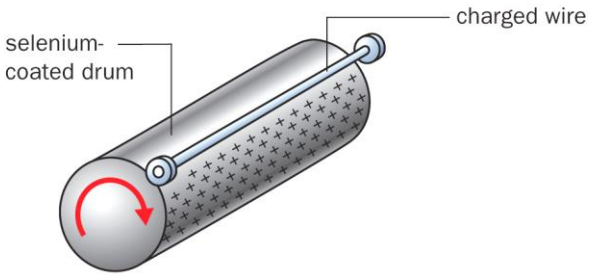


Fig. 6.1

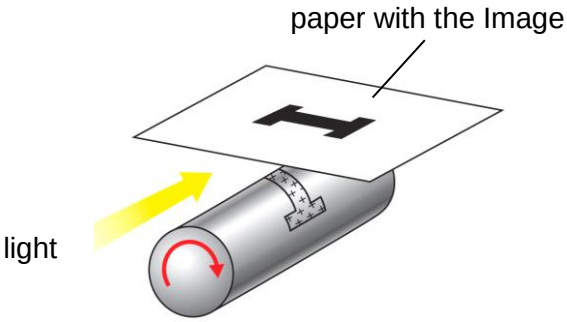


Fig. 6.2

A metal drum in the photocopier is coated with selenium, a photoconducting material. A highly charged wire is positioned near the rotating drum and charges it positively. The image to be photocopied is placed on a sheet of clear glass above the drum. As an intense beam of light is shone on the paper, a positively charged image is formed on the drum below it as shown in Fig. 6.2.

(i) Explain how the positive charges **outside** the image 'I' on the drum disappear in Figure 6.2.

……

……

……

…… [2]

(ii) Explain how the positive charges remain **within** the image 'I' on the drum.

……

……

……

…… [2]

(iii) The positively charged image on the drum attracted the charged toner powder as shown in Fig. 6.3 and the print appeared on a charged paper that is passed over the drum surface as shown in Fig. 6.4.

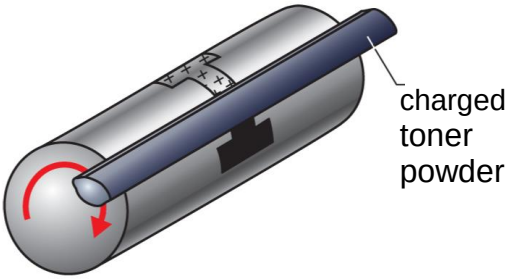


Fig. 6.3

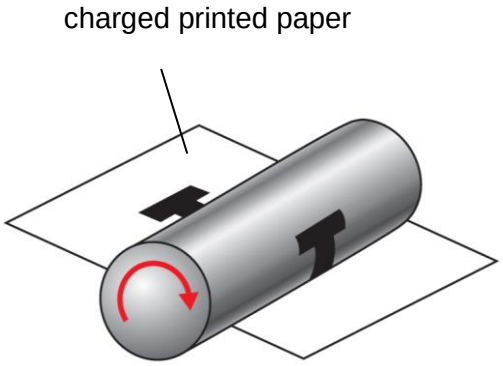


Fig. 6.4

Explain, with a reason, what the type of charges on the toner powder and the paper are.

.....

..... [1]

(b) There are two methods of spray painting a car body as illustrated in Fig. 6.5.

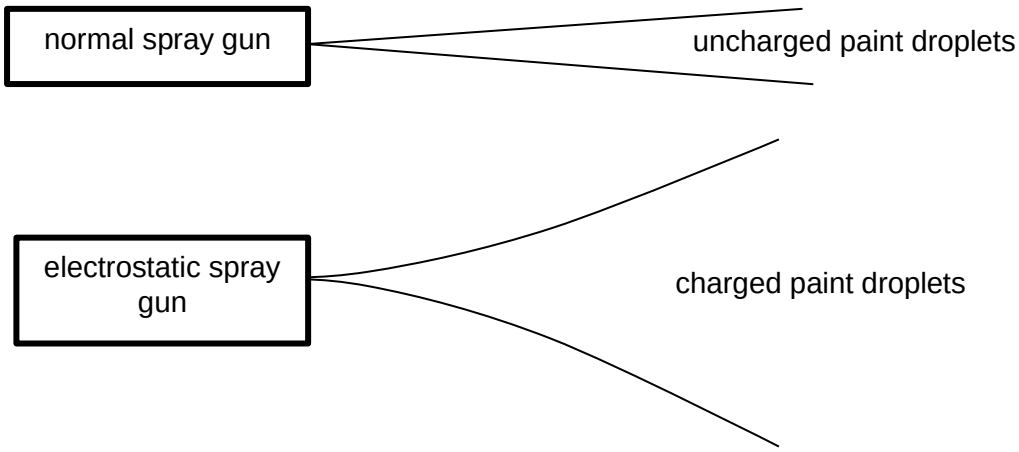


Fig. 6.5

It is found that for the same nozzle size and the same applied pressure on the paint at the nozzle, the electrostatic spray gun is able to cover a wider area of the car's body compared to a normal spray gun.

(i) Explain how the paint droplets acquire charges from the electrostatic spray gun.

..…….....……..

..…….....…….. [1]

(ii) Explain why the paint droplets from the electrostatic spray gun cover a bigger area than the paint droplets from the normal spray gun.

..…….....……..

..…….....…….. [1]

(iii) State one other advantage of using an electrostatic spray gun.

..…….....……..

..…….....…….. [1]

7 A Physics student plots the I–V characteristic graphs for a light-emitting diode (LED) and for a filament lamp. The LED is a semiconductor diode that emits light.

Fig. 7.1 shows the results obtained by the student.

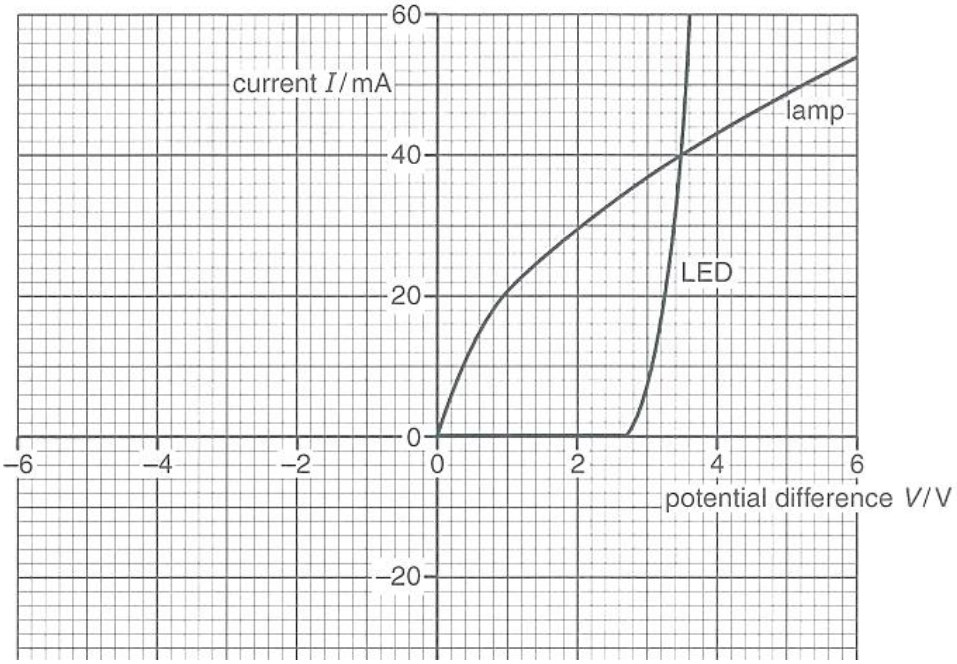


Fig. 7.1

(a) Describe how the resistance of the LED changes as the potential difference (p.d.) increases from zero.

.....

.....

..... [2]

(b) The filament lamp does not obey Ohm's law.

(i) State how Fig. 7.1 shows that the filament lamp does not obey Ohm's law.

..... [1]

(ii) State why the filament lamp does not obey Ohm's law.

.....

..... [1]

(c) There is a p.d. of 3.0 V across the lamp. Determine the resistance of the lamp.

resistance = ... [2]

(d) The filament lamp L and LED D are connected to a battery of electromotive force (e.m.f.) *E* and a fixed resistor R, as shown in Fig. 7.2.

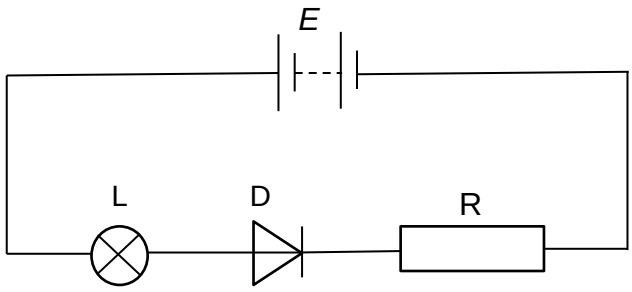


Fig. 7.2

The resistor R has a resistance of 200 Ω. The lamp is operating at normal brightness with p.d. of 3.0 V across it.

Determine the value of *E*.

E = ... [3]

8 **(a)** Fig. 8.1 shows a coil of wire wound on a soft iron core. A current is passed through the coil in the direction indicated by the arrows.

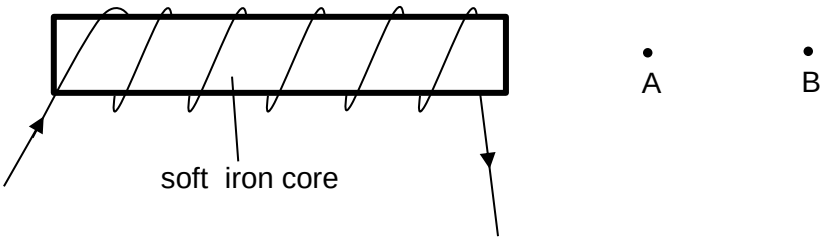


Fig. 8.1

(i) Show by drawing an arrow, the direction in which the north end of a compass needle would point when placed at position A in Fig. 8.1. Label the arrow C. [1]

(ii) A beam of electrons flows through the point B in a direction that is perpendicularly downwards into the paper. Show clearly by an arrow labelled F, the direction of the force exerted by the magnetic field on the electron beam. [1]

(iii) Explain how you determine the direction indicated in **(a)(ii).**

…….....

……..... [2]

(b) Fig. 8.2 shows a coil ABCD rotating clockwise in a magnetic field produced between the poles PQ of a permanent magnet. A current flows through the coil when the split ring commutator connected to the coil makes contact with the carbon brushes X and Y, connected to an external circuit.

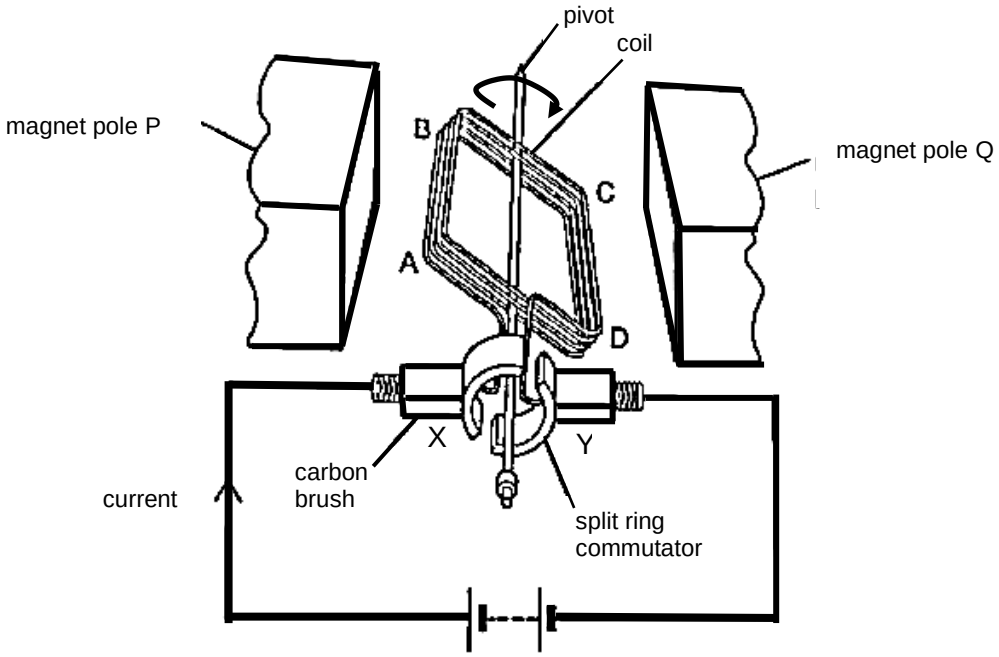


Fig. 8.2

(i) Deduce the polarities of the magnetic poles P and Q. Explain your answer.

.....

.....

.....

..... [2]

(ii) With reference to side AB of the coil, explain how the split-ring commutator ensures that the coil continues to rotate in the same direction.

.....

.....

.....

..... [2]

Name of candidate: _____ ( ) Class: _____ Calculator Model:

PHYSICS 6091/02

Paper 2 Theory

Date: 23 Aug 2021
Duration: 1 hr 45 min
Time: 1100 – 1245 h

Candidates answer on the Question Paper.
No additional materials are required

Section B (30 marks)

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

For Examiner's Use	
Section B	
9	
10	
11	
11 OR	
Total [30]	

9 Water moves up from the roots of a tree to its leaves through its vast network of conduits. These conduits are similar to capillary tubes. It is suspected that water moves up the conduits due to low pressure in the conduits which “sucks” the water upwards, or by capillary action, or a combination of both. Capillary action is a phenomenon whereby water rises up a small tube due to upward forces caused by the adhesion of water to the walls of the tube.

To investigate capillary action, a capillary tube, open at both ends, is supported vertically with one end immersed in water, as shown in Fig. 9.1. The water in the narrow bore of the tube forms a column of height *h*.

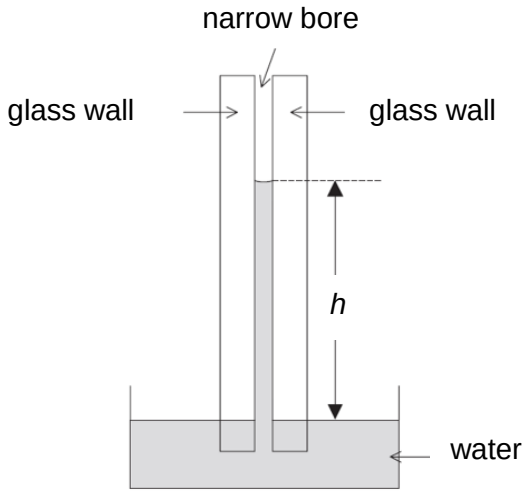


Fig. 9.1
(diagram not drawn to scale)

The height *h* of the water column for a particular capillary tube is measured as the temperature of water θ is varied. Table. 9.1 shows the data collected.

Table 9.1

θ / °C	*h* / cm
30	14.0
40	13.2
50	12.5
60	11.5
70	10.9
80	10.0

Fig. 9.2 shows the variation with temperature θ of height h.

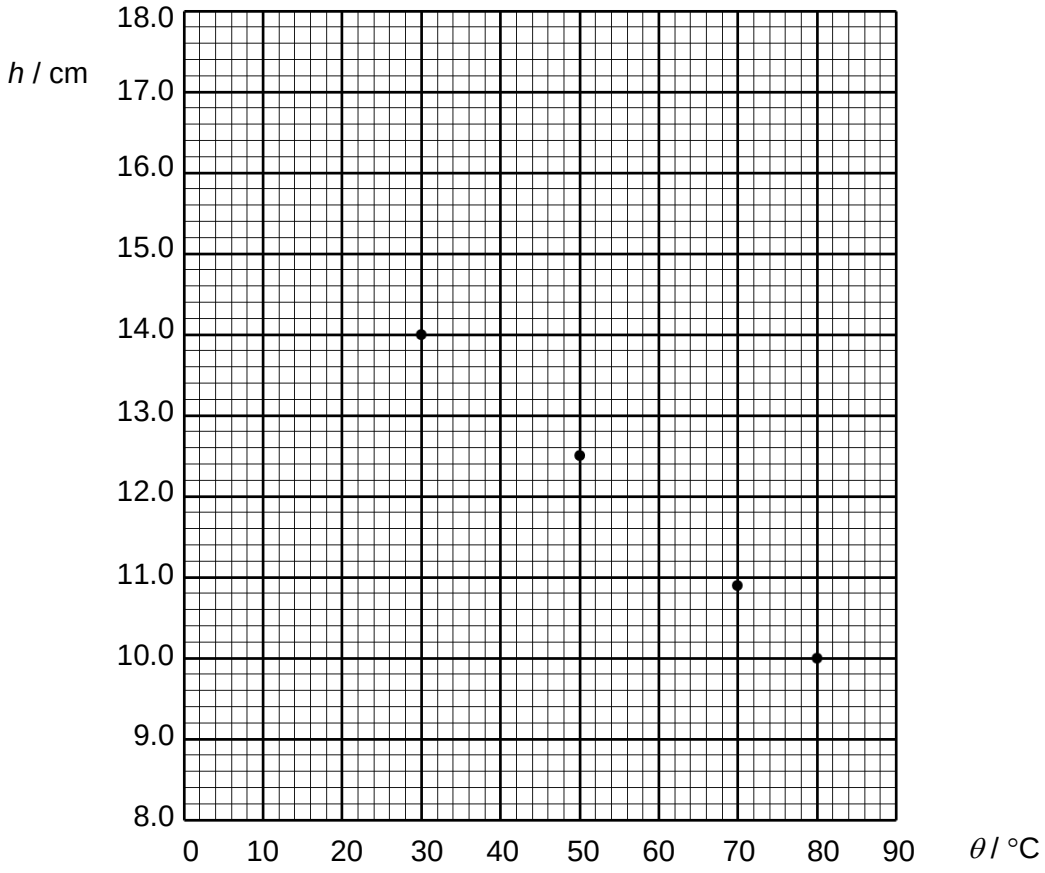


Fig. 9.2

(a) **(i)** On Fig. 9.2, plot the points for θ = 40 °C and θ = 60 °C. [1]

(ii) Using Fig 9.2, determine the height h_0 of the water column when the temperature is 0 °C.

h_0 =..... [1]

(iii) A student who looked at the data presented in Fig. 9.2 suggested that the variation of the height of the water with temperature is due to the internal energy of the water.

1. Explain what is meant by the *internal energy of water*.

.....

..... [1]

2. Compare and comment on the internal energy of water at 30°C and at 80°C.

.....

.....

.....

..... [2]

(b) The other means of moving water up a tree is to create a low pressure in the bore of the tubes in the tree.

(i) Suggest how low pressure can be created in the bore of the tubes in a tree.

.....

..... [1]

(ii) Using the following data, calculate the height at which water can be moved up a tree via low pressure in the bore of the tubes.

Atmospheric pressure P_o = 101 kPa

Pressure in the bore of the tubes in the tree P_T = 7.8 kPa

Density of water ρ = 1000 kg m^{-3}

The gravitational field strength g = 10 N/kg

height = ... [2]

(c) Suggest and explain how the height in **(b)(ii)** will change during a hot day.

.....

.....

.....

..... [2]

10 A ball is thrown vertically upwards from ground level. Air resistance is **not** negligible. The variation with time *t* of the speed *v* of the ball is shown in Fig. 10.1.

The ball reaches its maximum height at 1.75 s.

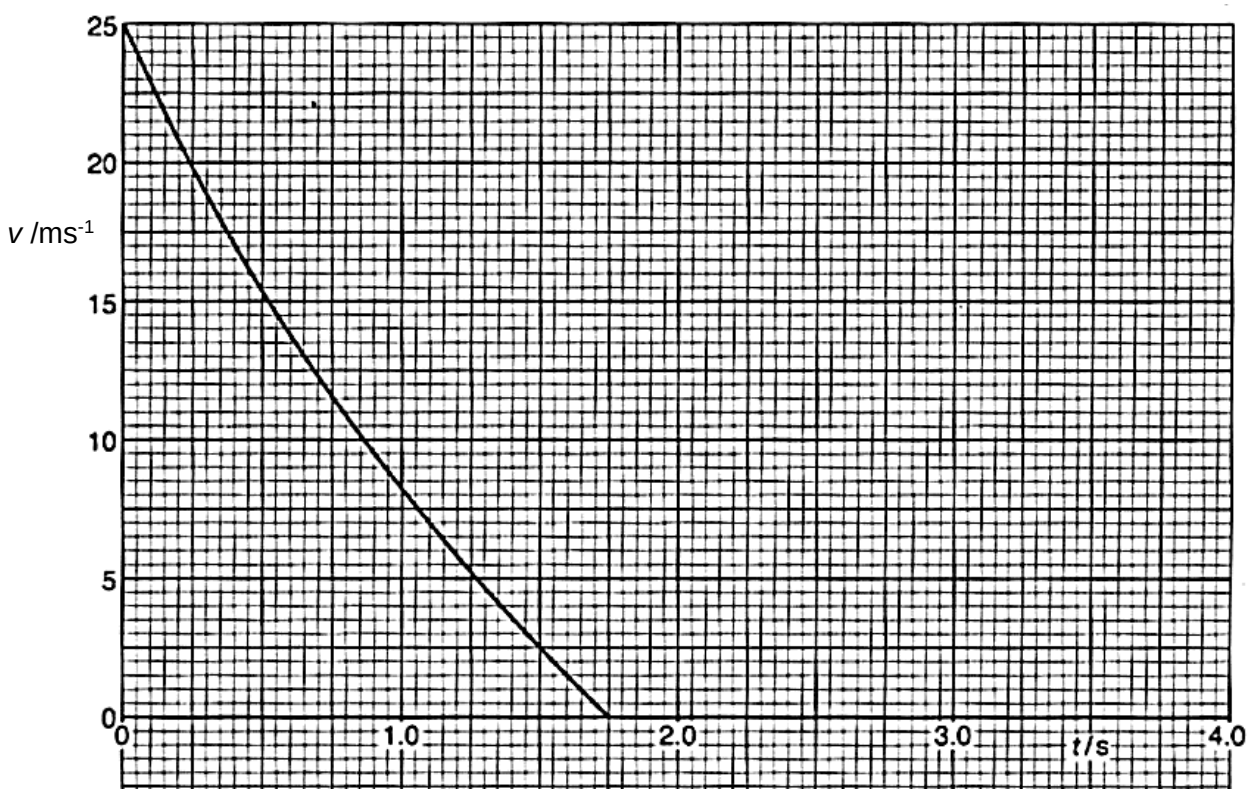


Fig. 10.1

(a) State how the speed of the ball varies with time.

.....

..... [1]

(b) **(i)** In the space below, draw a labelled diagram to show the forces acting on the ball on its upward motion.

[2]

(ii) Using Fig. 10.1 and **b(i)**, deduce and explain how the air resistance varies with the speed of the ball.

……

.....

.....

……..... [2]

(c) **(i)** Table 10.1 shows the speed, magnitude, and direction of the acceleration of the ball. Complete the table.

Table 10.1

time / s	speed / ms^{-1}	magnitude of acceleration / ms^{-2}	direction of acceleration
1.0	8.0	13	
1.75			

[2]

(ii) Determine the magnitude of the air resistance acting on the ball of mass 600 g at the instant of 1.0 s.

The gravitational field strength *g* is 10 N/kg.

air resistance = …….. [2]

(d) Suggest with a reason, whether the ball will take a longer or shorter time than 1.75 s to return to the ground from the maximum height.

……

……

…… [1]

11 EITHER

(a) Fig. 11.1 shows two methods of sending television signals to points on the Earth's surface. One method is to transmit radio waves directly to the receiver. A second method is to send the television signals via a satellite in space.

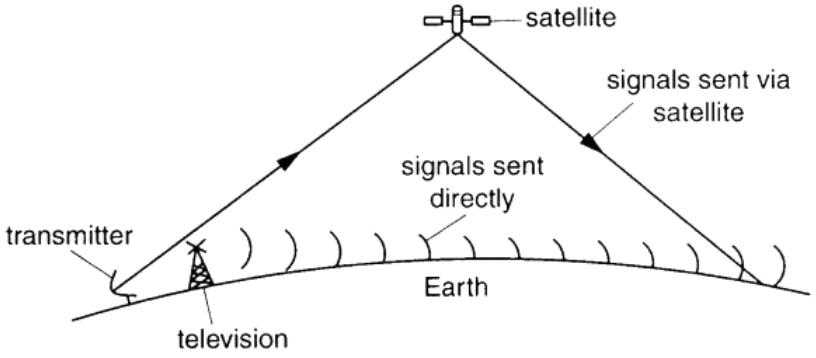


Diagram is not drawn to scale

Fig. 11.1

(i) State an advantage of using radio waves to transmit the television signal.

……

…….. [1]

(ii) State which region of electromagnetic spectrum is used for the second method of transmitting television signals.

……

…… [1]

(iii) State an advantage and a disadvantage of using the waves in the second method.

……

……

…….. [2]

(b) Sound wave is a longitudinal wave. When a sound wave travels through air, the displacement of the air molecules with distance at a particular instant is shown in Fig. 11.2.

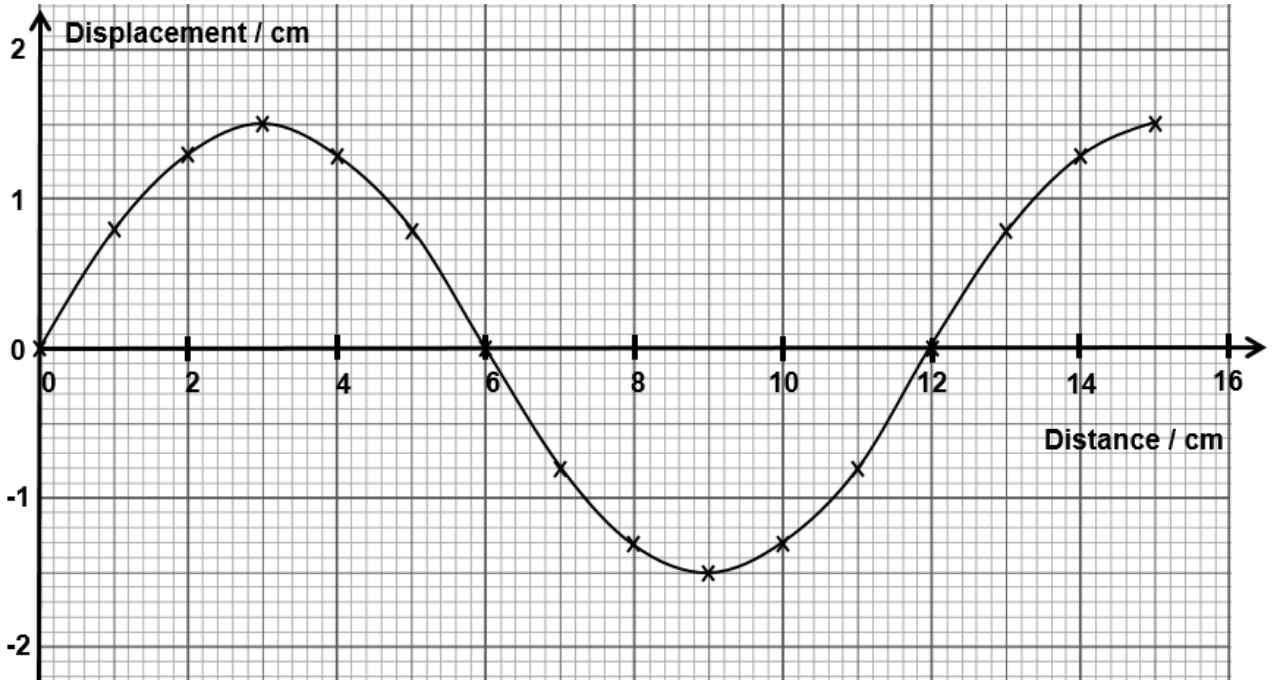


Fig. 11.2

(i) Fig. 11.3 shows the rest positions '●' of some of the air molecules before the sound wave travels through the air.

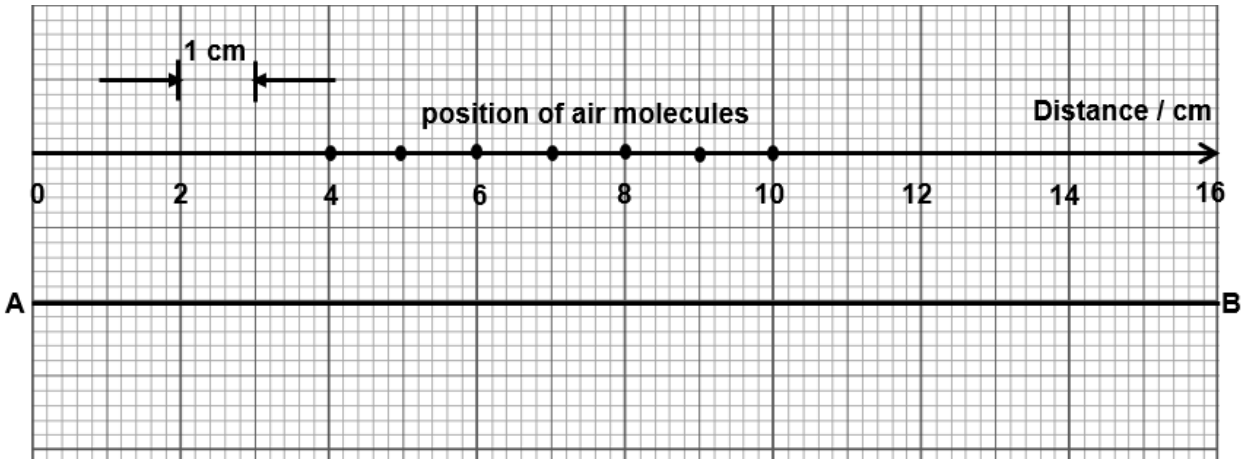


Fig. 11.3

Using the graph of Fig. 11.2, and taking the displacements to the right as positive,

1. draw the positions of the **displaced** air molecules, on the line AB in Fig. 11.3 when the sound wave travels through the air.

2. for one of the displaced air molecule, draw an arrow to indicate the amplitude of the wave. [3]

(ii) Explain how the displacements of the air molecules show that sound wave is a longitudinal wave.

……

…… [1]

(iii) Determine the wavelength and the frequency of the sound wave if the velocity of sound in air is 330 m s^{-1}.

wavelength = ……..…… [1]

frequency = …… [1]

OR

(a) Fig. 11.4 shows a copper rod AB initially at rest at the top of two metal rails inside a U-shaped magnet. The two metal rails are inclined slightly downward and the ends of the rails are connected with connecting wires to a centre-zero galvanometer.

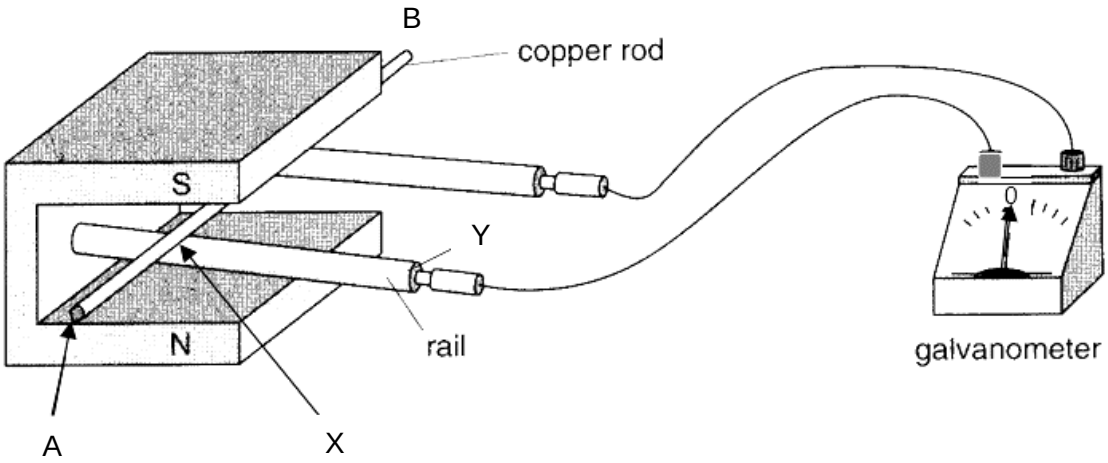


Fig. 11.4

Rod AB is released and it rolls down the rails from X to Y. An e.m.f. is induced in the circuit and the galvanometer shows a deflection.

(i) Explain why an induced e.m.f. is produced in the circuit.

……

……..……...

…..……..

…… [2]

(ii) Fig. 11.5 shows the circuit formed by the copper rod AB, the metal rails and the galvanometer G looking from the top.

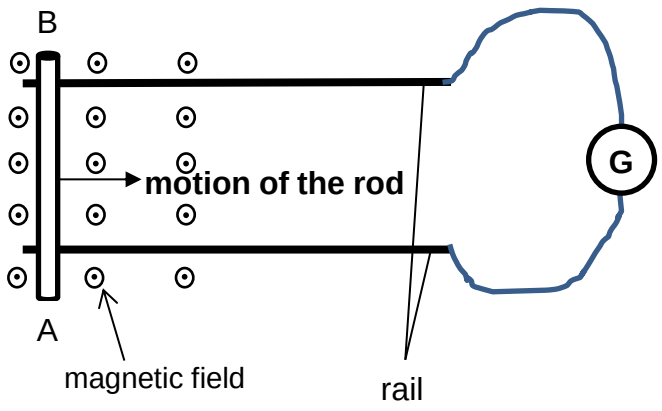


Fig. 11.5

As rod AB moves across the magnetic field, the galvanometer shows a deflection.

1. Indicate with an arrow on rod AB in Fig. 11.5, to show the direction of the induced current flow in the circuit. [1]

2. Explain why the induced current flows in the direction indicated.

.....

.....

.....

..... [2]

(b) Fig. 11.6 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

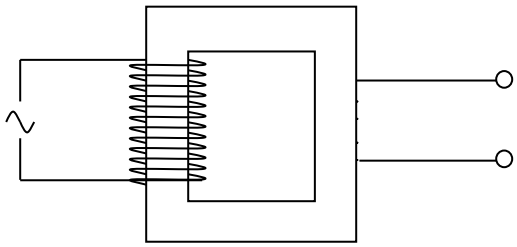


Fig. 11.6

Table 11.1

Coil	Number of turns
J	50
K	100
L	1 000
M	1 500

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 11.1.

(i) Based on Table 11.1, determine the most suitable pair of coils for making the primary coil and secondary coil of the transformer.
Show your working clearly on how you decide on the choice of the coils.

primary coil = …… [1]

secondary coil = …….. [1]

(ii) Assume that the transformer is 75 % efficient and the power output is 15 kW, determine the current flowing in the primary coil.

current = …… [2]

(iii) State and explain one feature that can improve the efficiency of this transformer.

……

…….. [1]

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