2022-23
S6 PHY
MOCK EXAM
PAPER 1B

B

Belilios Public School
2022-2023
MOCK EXAMINATION
PHYSICS PAPER 1
Section B: Question-Answer Book

This paper must be answered in English.

Name	
Class	
Class number	

(1) Write your Name, Class and Class number in the spaces provided on this cover.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) Answer **ALL** questions.

(4) Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) Graph papers and supplementary answer sheets will be provided on request. Write your name, class and class number on each sheet, and fasten them with a string inside this Question-Answer Book.

Question No.	Marks
1	/6
2	/7
3	/10
4	/8
5	/9
6	/6
7	/9
8	/5
9	/8
10	/8
11	/8
Section B (65%)	/84
Section A (35%)	/33
Paper 1 Weighted Total	/100

Section B: Answer ALL questions. Parts marked with * involve knowledge of the extension component. Write your answers in the spaces provided.

1. Octadecan-1-ol is a white solid with low melting point (59.5 °C). Peter puts a test tube containing 100 g of octadecan-1-ol at room temperature (25 °C) in a beaker containing 1 kg of water initially at 90°C. Peter aims to find out the specific latent heat of fusion of octadecan-1-ol by measuring the water temperature when all the octadecan-1-ol has just melted.

   Given: the specific heat capacity of octadecan-1-ol = 2610 J kg^{-1} K^{-1}
   the specific heat capacity of water = 4200 J kg^{-1} K^{-1}

   (a) Estimate specific latent heat of fusion of octadecan-1-ol if the temperature of water is 78 °C

when all octadecan-1-ol is melted. (3 marks)

(b) The theoretical specific latent heat of fusion of octadecan-1-ol is 274 kJ kg^{-1}. Explain the difference. (1 mark)

(c) Liquid octadecan-1-ol floats on water. Mary suggests putting a thin layer of octadecan-1-ol onto the beaker of water to reduce the error. Explain the principle behind Mary's suggestion. (1 mark)

(d) Besides Mary's suggestion in (c), give ONE precaution to improve the accuracy of Peter's experiment. (1 mark)

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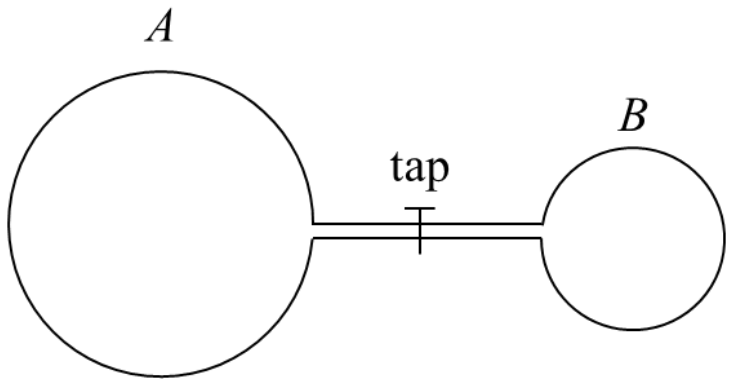
Answers written in the margins will not be marked.

*2. Two vessels A and B, of volumes $5V$ and $3V$ respectively, are connected by a tube of negligible volume with a tap as shown in Figure 2.1. Initially the tap is **opened** and both vessels are at the same temperature 30 °C. Vessel A contains 0.8 mol of an ideal gas at a pressure p initially.

Figure 2.1



(a) Find the amount of ideal gas (in mol) in vessel B. (2 marks)

Now the tap is **closed**. Vessel A is then heated to a constant temperature T_A while vessel B is put into a water bath of temperature 30 °C. The pressure of vessel A becomes $2p$.

(b) Write down the value of T_A. (1 mark)

Answers written in the margins will not be marked.

(c) The tap is now **opened again** until equilibrium is reached.

(i) Find the pressure in vessel B in terms of p when equilibrium is reached. (2 marks)

(ii) Explain, in terms of kinetic theory, the change in the pressure in vessel B. (2 marks)

Answers written in the margins will not be marked.

3. A 1.2-kg particle, initially at rest, slides down a rough inclined plane making an angle 10^{o} with the horizontal as shown in Figure 3.1. The particle attains a speed of 10 m s^{-1} when it travels a distance of 50 m and leaves the plane. Neglect air resistance.

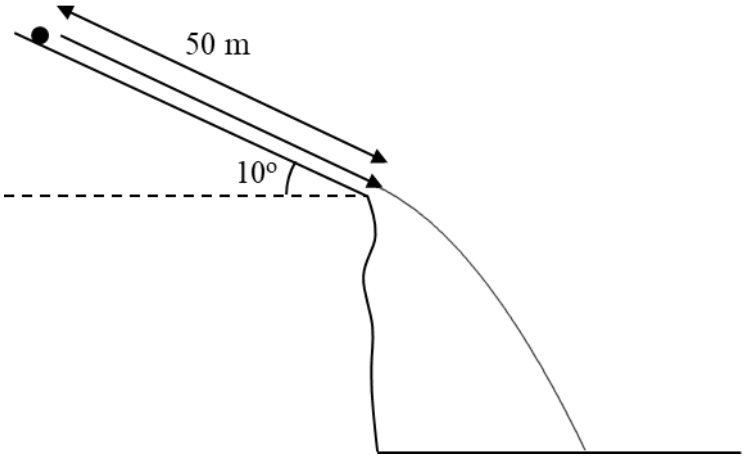


Figure 3.1

(a) (i) Find the acceleration of the particle on the inclined plane. (2 marks)

(ii) Find the frictional force acting on the particle by the inclined plane. (2 marks)

Answers written in the margins will not be marked.

The particle leaves the plane at the velocity 10 m s^{-1} at an angle of 10^{o} below the horizontal. It hits the horizontal ground after 3.5 s.

*(b) Just before the particle hits the ground,

(i) find the speed of the particle; (3 marks)

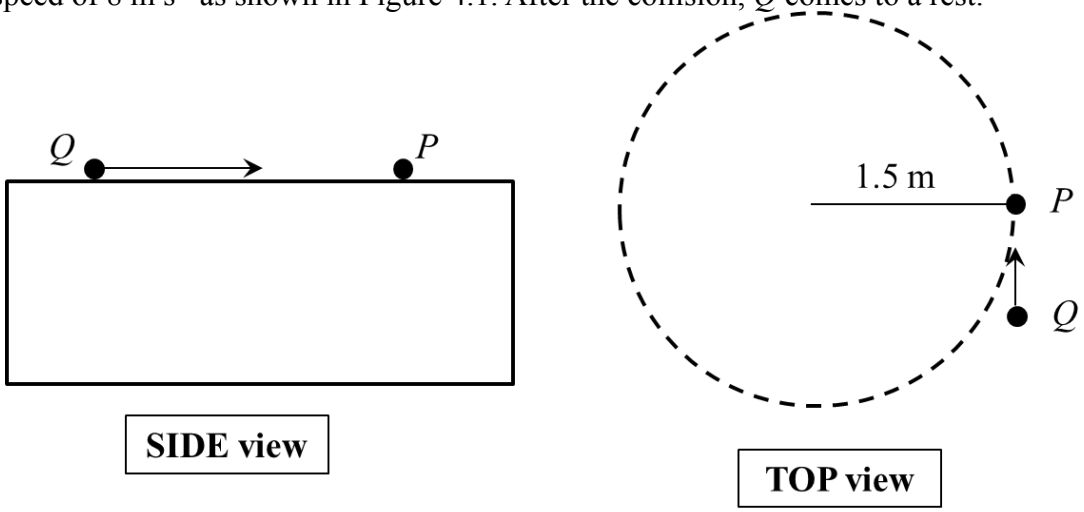
(ii) find the direction of motion, in terms of the angle made with the horizontal. (1 mark)

*(c) Find the vertical distance the particle travels in air. (2 marks)

Answers written in the margins will not be marked.

4. Ball P of mass 300 g, sitting on a smooth horizontal surface, is attached to a fixed point with a light inextensible string of length 1.5 m. Another ball Q of mass 250 g has a head-on collision with P at a speed of 8 m s^{-1} as shown in Figure 4.1. After the collision, Q comes to a rest.

Figure 4.1



(a) (i) Calculate the speed of P just after the collision. (2 marks)

(ii) Find out the percentage loss of the total kinetic energy due to the collision. State also the energy conversion during the collision. (2 marks)

Answers written in the margins will not be marked.

(b) After the collision, *P* undergoes a horizontal uniform circular motion.

*(i) Calculate the tension in the string. (2 marks)

(ii) *P* hits *Q* after a complete cycle. Will *P* become at rest just after the collision? Explain your answer. (2 marks)

Answers written in the margins will not be marked.

5. Figure 5.1 shows the top view of a ripple tank. Vibrator *S* is turned on to send continuous water waves of frequency 10 Hz towards two slits *A* and *B* of separation 5 cm. *XY* is a line equidistant from *A* and *B*. Alternate maximum and minimum amplitudes are observed along *PY*. Region *Q* and *R* are of the same depth.

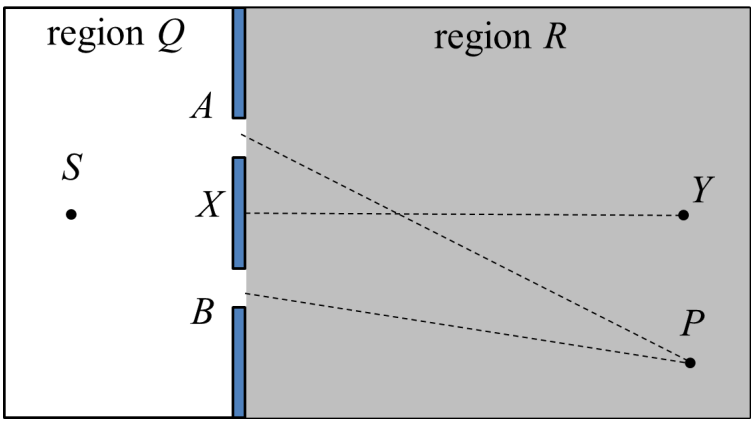


Figure 5.1

(a) Name the phenomenon when water waves passing through the slits. (1 mark)

(b) Explain why alternate maximum and minimum amplitudes are observed along *PY*. (2 marks)

Point *P* is the second minimum amplitude away from *Y*. $AP = 15$ cm and $BP = 12$ cm.

(c) (i) State the path difference at *P* in terms of wavelength λ. (1 mark)

Answers written in the margins will not be marked.

(ii) Find the wave speed of the water wave. (3 marks)

(d) A rectangular block is placed at region *R* making the water shallower. It is found that the first maximum is found at *P*. Find the percentage change in wave speed in region *R*. (2 marks)

Answers written in the margins will not be marked.

6. Read the following passage about **thermistor** and answer the questions that follow.

A thermistor is a type of resistor whose resistance is strongly dependent on temperature, more so than in standard resistors.

Thermistors are divided based on their conduction model. Negative Temperature Coefficient (NTC) thermistors have less resistance at higher temperatures, while Positive Temperature Coefficient (PTC) thermistors have more resistance at higher temperatures, i.e. a PTC thermistor's resistance is directly proportional to kelvin temperature.

Thermistor are widely used as inrush current limiters, temperature sensors, self-resetting overcurrent protectors, and self-regulating heating elements. An operational temperature range of a thermistor is typically between −100 °C and 300 °C.

When measuring the temperature of the environment, a current flows through a thermistor. This generates heat, which raises the temperature of the thermistor above that of its environment. This electrical heating may introduce a significant error.

Consider a PTC thermistor *X*. The resistance of *X* at 30 °C is 4000 Ω.

(a) Find the resistance of *X* when its temperature is 100 °C. (2 marks)

(b) To measure the temperature of the environment, a simple thermistor thermometer consists of a circuit as shown in Figure 6.1. Neglect the internal resistance the dry cell and assume the voltmeter used is ideal.

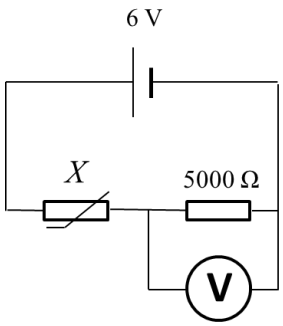


Figure 6.1

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Answers written in the margins will not be marked.

(i) Find the voltmeter reading when the temperature of the thermistor is 30°C. (2 marks)

(ii) State whether the temperature of the environment is higher than, equal to or lower than 30 °C when the voltmeter reading is as that in (b)(i). Explain your answer. (2 marks)

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7. An object *AB* is placed in front of a lens *L* as shown in Figure 7.1. A light ray from *B* is refracted by *L* as shown.

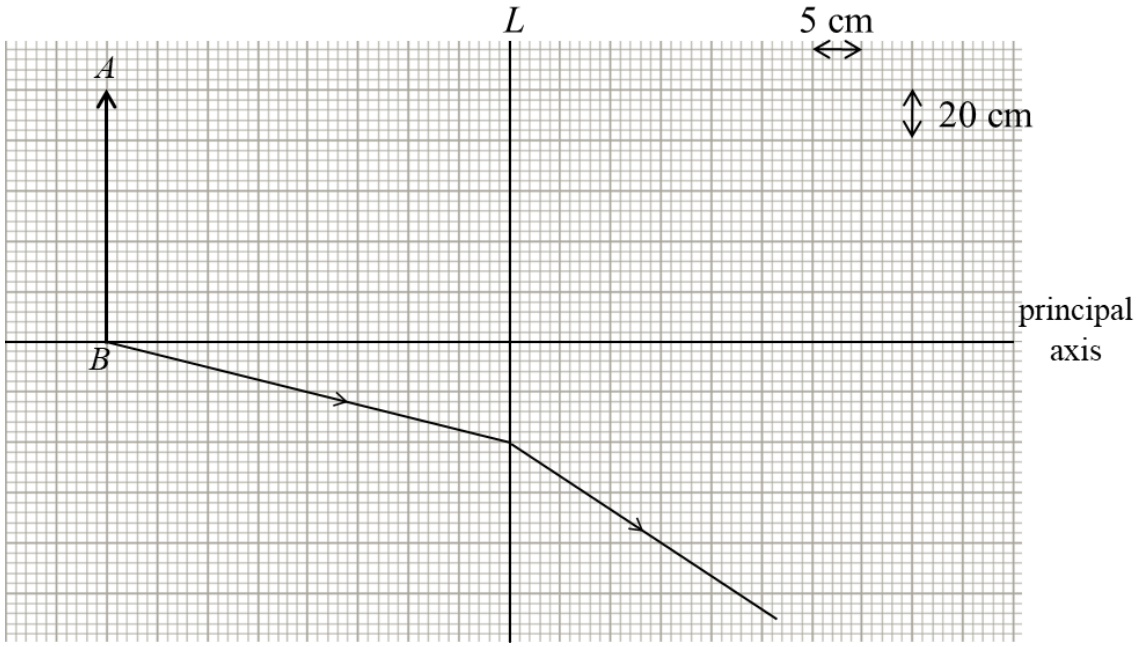


Figure 7.1

(a) What kind of lens is *L*? Explain your answer. (2 marks)

(b) (i) Draw a suitable line so as to locate the image of *B* (denote as *B*'). (1 mark)

(ii) Hence calculate the magnification of the image *A'B'* of object *AB*. (2 marks)

(iii) Mark the image *A'B'*. (1 mark)

(iv) By drawing ONE suitable ray, locate and mark the principal focus *F* of the lens *L* on your diagram and find the focal length *f*. (3 marks)

Answers written in the margins will not be marked.

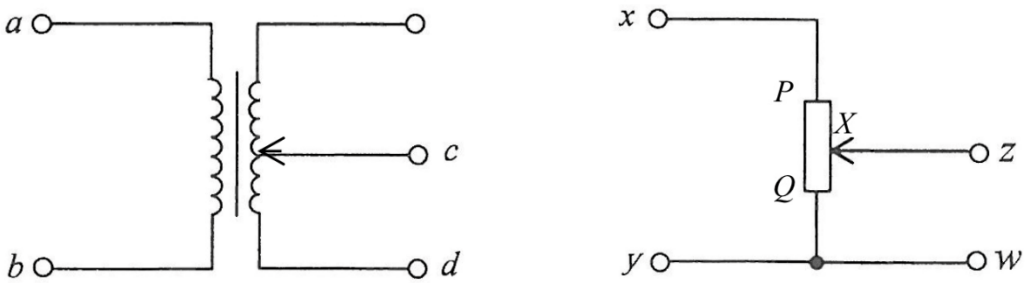
8. You are given the following apparatus:

A d.c. power pack, a voltmeter, an ammeter, a long copper wire with uniform cross-section, some connective wires, crocodile clips and a resistor

With the aid of a circuit diagram, describe an experiment to investigate quantitatively the relationship between the length of a copper wire and its resistance. (5 marks)

9. Figure 9.1 below show two circuits. The transformer in circuit I is 90% efficient. In circuit II, there is a potential divider PQ of total resistance 100 Ω. Terminal z is connected to a movable point X by a sliding contact.

Figure 9.1



Circuit I Circuit II

A 24 V v ected to ntical

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'12 V 6 W' light bulbs are connected to *cd* and *zw* respectively and both light bulb works at its rated values.

(a) Consider circuit I.

(i) How many turns of coil is connected to *cd* if the primary coil of the transformer has 480 turns? (1 mark)

(ii) Find the current drawn from the power supply. (2 marks)

Answers written in the margins will not be marked.

(b) Consider circuit II. Find the ratio $XQ : PQ$. (3 marks)

(c) State ONE advantage and ONE limitation of using circuit I to operate a light bulb over using circuit II. (2 marks)

Answers written in the margins will not be marked.

10. Figure 10.1 shows two metal rails with separation of 0.2 m fixed on a plane inclined to the horizontal by 20°. A uniform magnetic field of flux density 5 T is applied perpendicular to the inclined plane. The terminals *A* and *D* of the metal rails are connected to a d.c. power supply (not shown in the figure). A metal rod *PQ* is placed across *AD* as shown. As current passes through, the metal rod starts to accelerate up the slope and attains a constant speed after a while. Figure 10.2 shows the side view. Assume the metal rod and the metal rails are all smooth and they are of negligible electrical resistance.

Figure 10.1

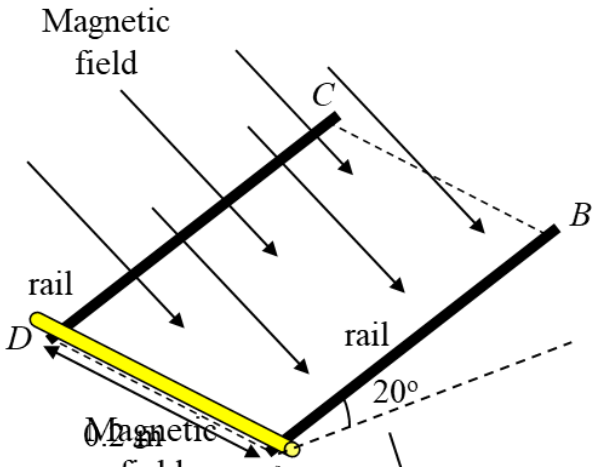

Figure 10.2

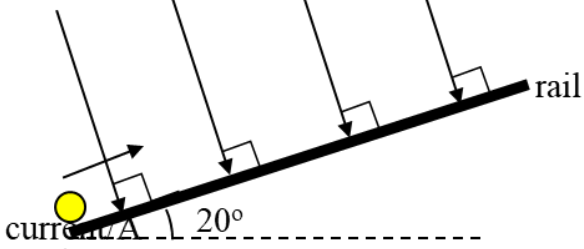

Figure 10.3

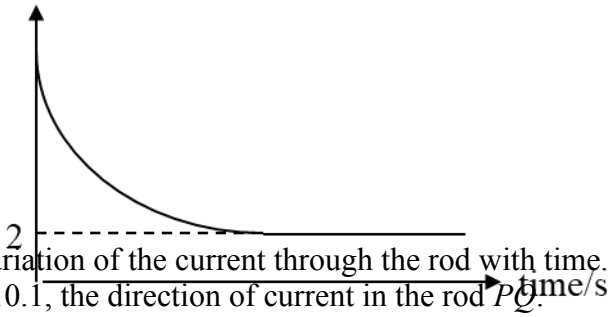

Figure 10.3 shows the variation of the current through the rod with time.

(a) Indicate, on Figure 10.1, the direction of current in the rod *PQ*. (1 mark)

Answers written in the margins will not be marked.

(b) Consider the period when the rod moving up with constant velocity.

(i) Draw all the forces acting on the rod in Figure 10.2. (2 marks)

(ii) Find magnitude of the magnetic force acting on the rod. Hence, find the mass of the rod. (4 marks)

(iii) Describe the energy conversion when the rod is moving up at constant velocity. (1 mark)

Answers written in the margins will not be marked.

11. A polonium-210 ($^{210}_{84}\mathrm{Po}$) nucleus undergoes α -decays to form a stable lead (Pb) nucleus. The half-life of Po-210 is 138 days.

(a) Write a nuclear equation for the decay of Po-210. (2 marks)

Given: the mass of Po-210 nucleus = 209.98286 u
the mass of daughter Pb nucleus = 205.97447 u
the mass of α particle = 4.002603 u

*(b) Estimate the maximum energy released, in MeV, in the decay of a nucleus of Po-210. (2 marks)

The activity of a Po-210 sample is 250 Bq.

*(c) Estimate the number of Po-210 nuclei decayed after 1 year (365 days). (4 marks)

END OF PAPER

Answers written in the margins will not be marked.