2021-2022
PHY
PAPER 1B

Bishop Hall Jubilee School
2021-2022 First Mock Examination

F.6 PHYSICS PAPER 1
SECTION B: Question-Answer Book

Name	
Class	
Class No.	

Date: 23-02-2022
Time: 8:20 – 10:50
Duration: 150 mins
Total page no.: 10 (including cover page)
This paper must be answered in English

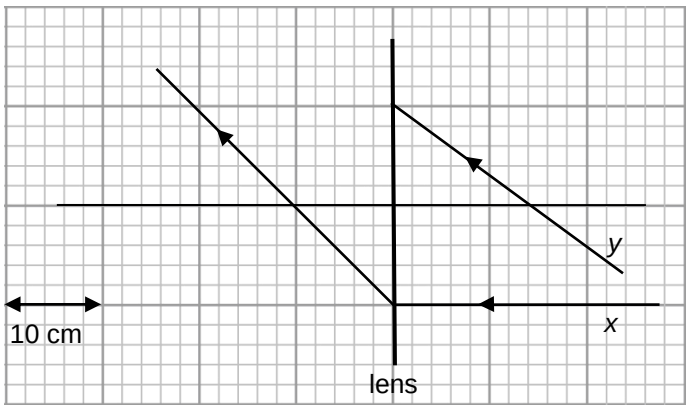
Q.1	/ 5
Q.2	/ 10
Q.3	/ 13
Q.4	/ 10
Q.5	/ 10
Q.6	/ 5
Q.7	/ 10
Q.8	/ 12
Q.9	/ 10
Total	/ 85

INSTRUCTIONS FOR SECTION B

1. After the announcement of the start of the examination, you should first write your name, class and class number in the space provided in Page 1.
2. Refer to the general instruction on the cover of the Question Paper for Section A.
3. Answer **ALL** questions in this paper.
4. Write your answers in the spaces provided in this Question-Answer Book.
5. Graph paper, rough work sheets and supplementary answer sheets will be supplied on request. Write down your name, class and class number if necessary.

Section B (85 marks, 60%): Answer **ALL** questions.

1 A ray *x* passes through a lens as shown.



(a) Is the lens convex or concave? (1 mark)

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(b) What is the focal length of the lens? (1 mark)

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(c) In the above diagram draw the refracted ray of ray *y*. Show clearly how you get the answer. (3 marks)

2 Lunch jar is popular in Hong Kong. It can keep food warm for a long time.

The structure of a lunch jar is similar to that of a vacuum flask. It has two layers of steel, and a vacuum space in between the two layers.

(a) Which type(s) of heat transfer does the vacuum layer of the lunch jar reduce? (2 marks)

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(b) Explain how the shiny outer surface helps reduce the energy loss from the food. (2 marks)

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(c) The producer of a kind of lunch jar claims that by putting 1 kg of 95 °C hot water into their lunch jar, its temperature will stay at 73 °C or above after 6 hours. Taking the final temperature to be 73 °C, estimate the energy lost from the water in this case. (Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$) (2 marks)

(d) Someone also uses a lunch jar to cook food. One of the cooking receipts is as follows.

1 Put the following ingredients into the jar and wait for 5 minutes. The temperatures of the ingredients become about the same. The energy loss in this step is negligible.

Ingredient	**Specific heat capacity (J kg^{-1} $°C^{-1}$)**	**Mass (kg)**	**Initial temperature (°C)**
water	4200	0.6	95
tomato	3980	0.2	25
cooked rice	2930	0.2	16

2 Pour out the water and fill another 0.6 kg of 95 °C hot water into the lunch jar.

3 Keep the lunch jar closed for 6 hours. The energy lost from the mixed food during this time period is about the same as that in (c).

Estimate the temperatures of the ingredients after step 1 and step 3 respectively. (4 marks)

3 A sealed container of fixed volume contains 3 moles of an ideal gas at 25 °C. The gas is heated at 20 W for |1 minute. Assume the energy absorbed by the container is negligible. Take the molar mass of the gas to be 32.0 g mol^{-1}.

(a) (i) Estimate the temperature of the gas after heating. (4 marks)

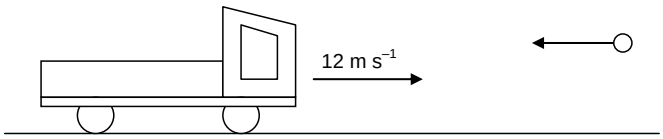
(ii) Estimate the root-mean-square speed of the gas molecules after heating. (2 marks)

(b) Explain the change in pressure in the container using kinetic theory. (4 marks)

(c) Estimate the energy needed to raise the temperature of 1 kg of this gas by 1 °C in a fixed volume. (2 marks)

(d) How will the answer in (c) be different if the ideal gas has a larger molar mass? (1 mark)

4 A truck of mass 2000 kg is travelling at a speed of 12 m s^{-1} on a horizontal road. Suddenly, a tennis ball of mass 56 g flies out and hits the truck. Just before it hits the truck, its velocity is opposite to the direction of motion of the truck and has a magnitude of 3 m s^{-1}.

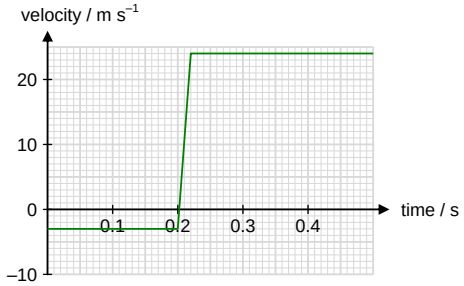


(a) After the ball hits the truck, it reverses its direction of motion and flies away at 24 m s^{-1}.

(i) Find the decrease in speed of the truck after the impact. (2 marks)

(ii) Is this an elastic collision? Justify your answer with suitable calculations. (3 marks)

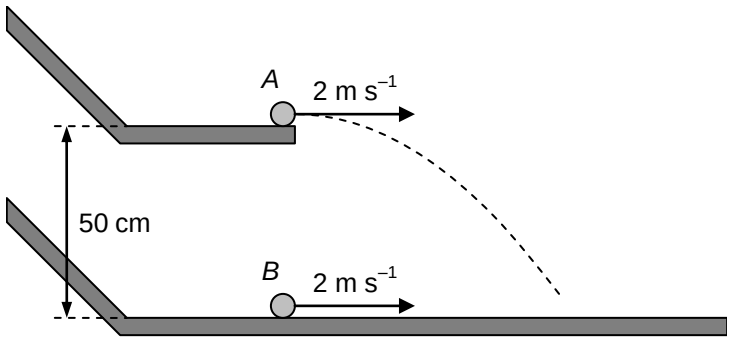
(b) The following figure shows the velocity–time graph of the tennis ball.



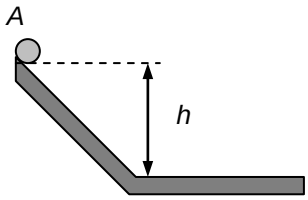
(i) Find the acceleration of the ball during the impact. (2 marks)

(ii) Find the magnitude of the force applied on the truck by the ball during the impact. (3 marks)

5 In an experiment, two balls are set to move on two smooth tracks as shown in the figure below. When ball *A* leaves the upper track, it is vertically above ball *B* and both balls are moving at the same horizontal velocity of 2 m s^{-1}. Ball *A* undergoes projectile motion after leaving the track.



(a) At the beginning of the experiment, the two balls are simultaneously released from rest at the ends of the two tracks. The following figure shows the initial position of ball *A*.



Find the height *h*. (2 marks)

(b) Consider the time period after ball *A* leaves the upper track.

(i) In the space below, draw the free-body diagrams for balls *A* and *B*. (2 marks)

(ii) From Newton's laws of motion, explain why the two balls will collide. (3 marks)

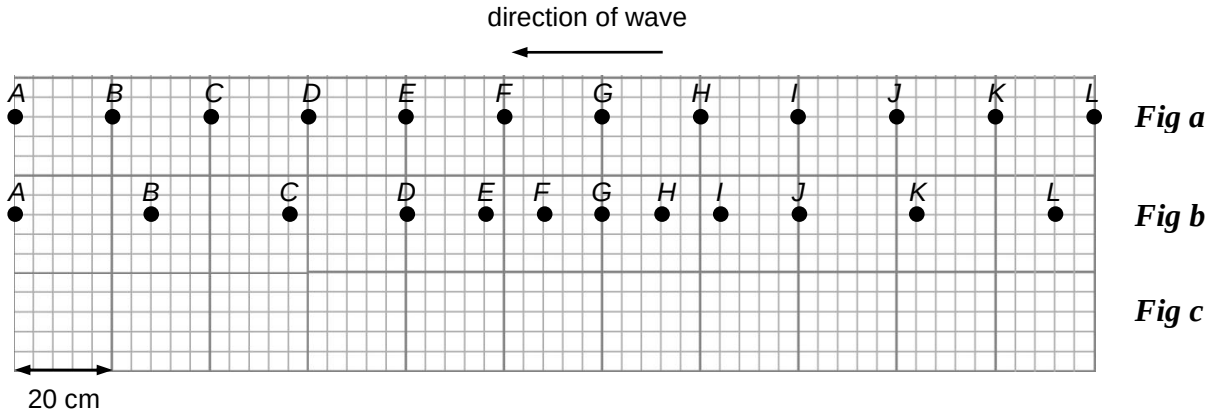
(iii) Find the horizontal distance travelled by ball *A* before it collides with ball *B*. (3 marks)

6 A car is making a turn as shown in the figure below. The maximum friction acting on a car on the road is given by $f_{max} = 0.6N$, where N is the normal force acting on the car by the road. The radius of curvature of the turn is 50 m.

(a) If the road is horizontal, derive a safety speed limit. (2 marks)

(b) To allow cars to travel at higher speeds, the road is banked. Suggest a banking angle if the average speed of the cars on the road is 36 km h^{-1}. (3 marks)

7 A longitudinal wave is travelling from right to left in a medium. Figure a shows the equilibrium positions of particles *A* to *L* in the medium. Figure b shows the positions of the particles at a certain time $t = 0$.



(a) State one particle which is

(i) at the centre of rarefaction,

(ii) moving to the left

at time $t = 0$. (2 marks)

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(b) Suppose each particle takes 2 s to make one complete vibration. Find

(i) the frequency of the wave,

(ii) the wave speed. (4 marks)

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(c) Sketch the displacement−distance graph of the wave at $t = 0$. Take the displacement to the left as positive. (2 marks)

(d) Draw the positions of particles *D* and *G* at $t = 0.5$ s in Figure c. (2 marks)

8 Bob designs an induction kettle which consists of two parts: the base and the body (Fig a). The base has a solenoid *X* wound on an iron core and is connected to the mains supply. When the body is put on the base, its solenoid *Y* passes through the iron core of *X* (Fig b).

Fig a

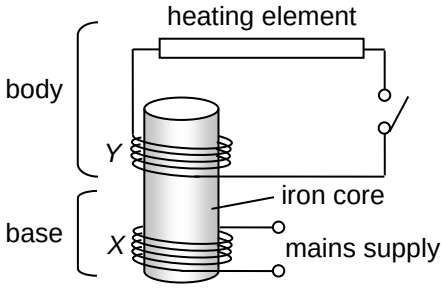

Fig b

Suppose *X* has 40 turns per cm and *Y* has 500 turns. *X*, *Y* and the iron core have the same radius of 0.1 m. The resistance of the heating element is 10 Ω and the resistance of the solenoids is negligible.

(a) Explain how the induction kettle works. (3 marks)

(b) What is the function of the iron core? (1 mark)

(c) (i) The current through *X* is 3 A at certain instant. Find the magnitude of magnetic flux density in *X*. (2 marks)

(ii) The current through *X* increases to 8 A in 3 ms. Assume there is no flux leakage and energy loss. Find the average heating power of the kettle within this period. (4 marks)

(d) Using the answer in (c)(ii), estimate the time that the kettle needs to boil 2 kg of water at 25 °C. The specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$. (2 marks)

9

Radiation poisoning

There was incident of radiation poisoning that drew a lot of public attention. A former Russian spy Alexander Litvinenko suddenly fell ill in London and was sent to a hospital. The doctors found that he was poisoned by polonium-210 (Po-210), an α source with a half-life of 138 days. It was believed that Litvinenko had swallowed 26.5 μg of Po-210 secretly added to his tea. Such a mass should contain approximately 7.60×10^{16} Po-210 atoms.

Traces of Po-210 were then detected at different locations around London visited by Litvinenko after he was poisoned. However, the British Health Protection Agency told the public that Po-210 was not hazardous to health as long as it remained outside the body.

(a) Explain why

(i) Po-210 is not hazardous to health if it remains outside the body. (1 mark)

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(ii) it is deadly if polonium-210 is ingested. (1 mark)

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(iii) traces of Po-210 were found at locations visited by Litvinenko after he was poisoned. (2 marks)

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(b) The activity of polonium-210 in Litvinenko's body on the day he was poisoned was 4.42×10^9 Bq. Find the decay constant of polonium-210. (2 marks)

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(c) Calculate the time needed for the activity of polonium-210 to drop to one-fourth of its original value. (2 marks)

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(d) Suggest two safety precautions the doctors and nurses have to take when they handle a radiation poisoning patient in addition to normal medical procedures. (2 marks)

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End of paper