CNEC CHRISTIAN COLLEGE

Mock Examination (2021-22)
Form Six
Physics Paper 1
Section B : Question-Answer Book B

This paper must be answered in English.

INSTRUCTIONS

(1) Write your name, class and class number in the space provided on Page 1.

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

(3) This section carries 84 marks.

(4) Answer ALL questions. 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) Supplementary answer sheets will be provided on request.

Name	
Class	
Class number	

Question No.	Marks
1	**6**
2	**8**
3	**6**
4	**6**
5	**6**
6	**6**
7	**9**
8	**9**
9	**14**
10	**6**
11	**8**

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

1. Figure 1 shows a part of a solar power plant. A curved mirror is used to concentrate sunlight onto a water pipe inside a glass house. Water at 20 °C flows into the house through the pipe at a rate of 2 kg per second and becomes steam at 160 °C after heating. The steam is then used to drive a turbine to generate electricity.

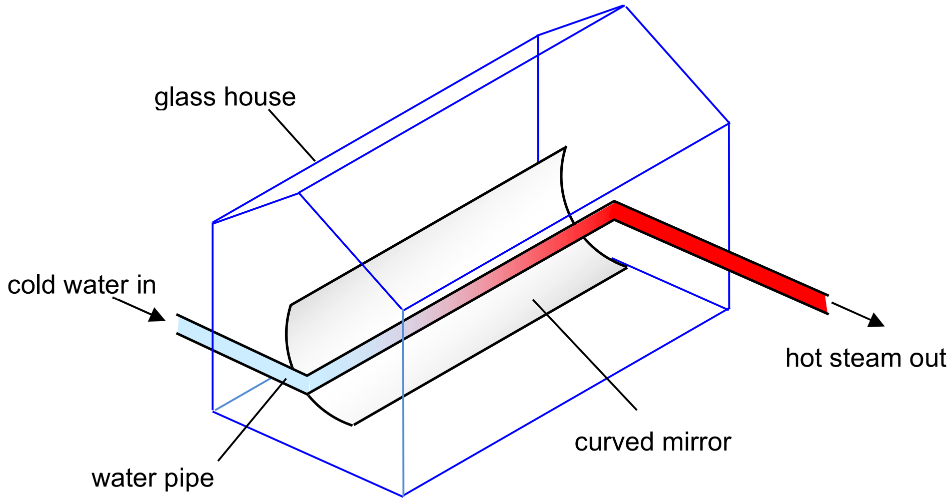

Figure 1

(a) What is the power absorbed by the water in the heating process? Assume all water vaporizes at 100 °C. (2 marks)

Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

specific heat capacity of steam = 2000 J kg^{-1} $°C^{-1}$

specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}

(b) Suggest how the glass house reduces heat loss from the pipe. (1 mark)

(c) What properties should the water pipe have in order to facilitate heat transfer? Suggest TWO of them. (2 marks)

(d) Not all the solar energy falling on the mirror is transferred to the water. Suggest ONE reason. (1 mark)

*2. A metal cylinder of volume 0.02 m^3 is on the sea surface where the temperature is 27 °C. It contains a compressed gas with pressure 18.0 atm (1 atm represents the standard atmospheric pressure). A diver carries the cylinder and dives 20 m down to the seabed where the temperature is 21 °C. (Assume the gas is ideal and the volume change of the cylinder due to temperature variation is negligible.)

(a) It is known that the pressure due to sea water increases by 1 atm every 10 m further down that one dives in the sea. What is the total pressure, in atm, at the seabed? (1 mark)

(b) After the diver has been on the seabed for some time, he inflates a balloon to a volume of 0.01 m^3 by using the cylinder of compressed gas. Assume that the balloon is inflated slowly so that the temperature of the gas does not change and the final pressure in the balloon is equal to that at the seabed.

(i) Find the gas pressure, in atm, in the cylinder just before the diver inflates the balloon. (2 marks)

(ii) Calculate the gas pressure, in atm, in the cylinder after the balloon has been inflated. (3 marks)

(iii) What fraction of the gas originally in the cylinder has been used to inflate the balloon? (2 marks)

3. Read the following article and answer the following questions.

Anti-gravity lean

Micheal Jackson was a famous pop star. One of his iconic dance move on the stage is called the 'anti-gravity lean', which gives an illusion that the dancer is defying gravity.

The dancer is able to do this because of a pair of specially designed shoes. The heel of the shoe is mounted with a V-shaped steel plate. Before leaning forward, the V-shaped plate is engaged to a peg, which rises from the floor of the stage at the appropriate moment.

A patent was issued to Micheal Jackson in 1993 for the design of this shoe used on stage performance.

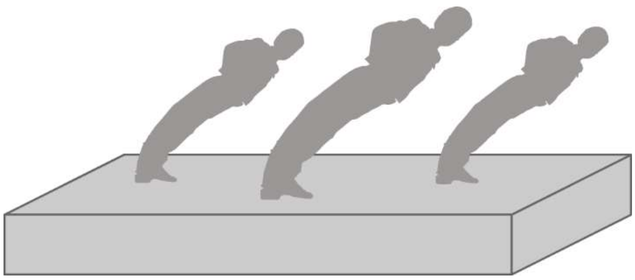

Figure 3a

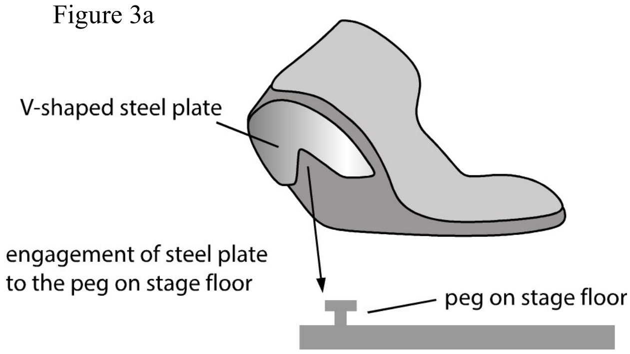

Figure 3b

(a) Figure 3c shows a dancer performing the 'anti-gravity lean'. V denotes the point where the V-shaped plate engaged to a peg, T denotes the tip of his foot, and G denotes his centre of gravity. Draw the vertical forces acting on the dancer at these three points. (2 marks)

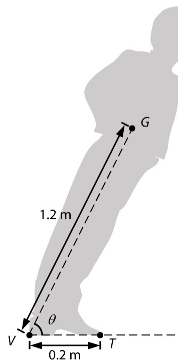

Figure 3c

(b) Without the special shoes, it is possible for the dancer to hold this posture? Explain why. (2 marks)

(c) The distance between V and T is 0.2 m, and the length between V and G is 1.2 m. The weight of the dancer is 700 N, and the maximum vertical force at V is 1800 N. Find the minimum angle θ that his body makes with the horizontal floor. (2 marks)

4. Two objects X and Y are connected by a light inextensible string over a smooth pulley as shown. The masses of X and Y are 0.2 kg and 0.1 kg respectively. Y is placed on a rough plane which is inclined at 30° to the horizontal. The system is released from rest. When X has fallen 0.5 m, it attains a speed of 1 m s^{-1}.

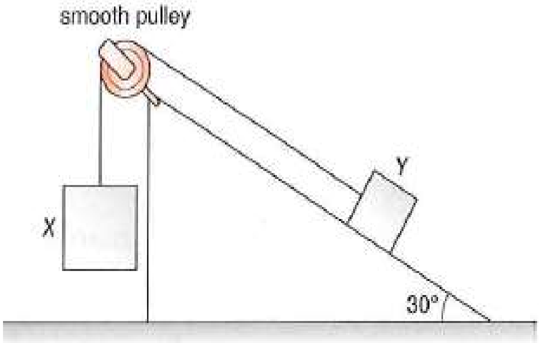

Figure 4

(a) Find the potential energy lost by X. (2 marks)

(b) Find the kinetic energy gained by Y. (2 marks)

(c) Find the average friction acting on Y. (2 marks)

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5. A space shuttle is launched into a circular orbit around the earth at an altitude of 2.4×10^5 m above the Earth surface. (Given: radius of the earth = 6.4×10^6 m)

(a) (i) Find the orbital speed of the shuttle. (3 marks)

(ii) Calculate the gravitational force acting on an astronaut of mass 60 kg in the shuttle. (2 marks)

(b) Explain why the astronauts appear to be "weightless" in the orbit. (1 mark)

6. Pinky views a light bulb through a red filter with a plane transmission grating. The grating is held at one end of a metre rule *A* which is aimed at the bulb. At the other end of rule *A*, a second rule *B* is placed perpendicularly to rule *A*.

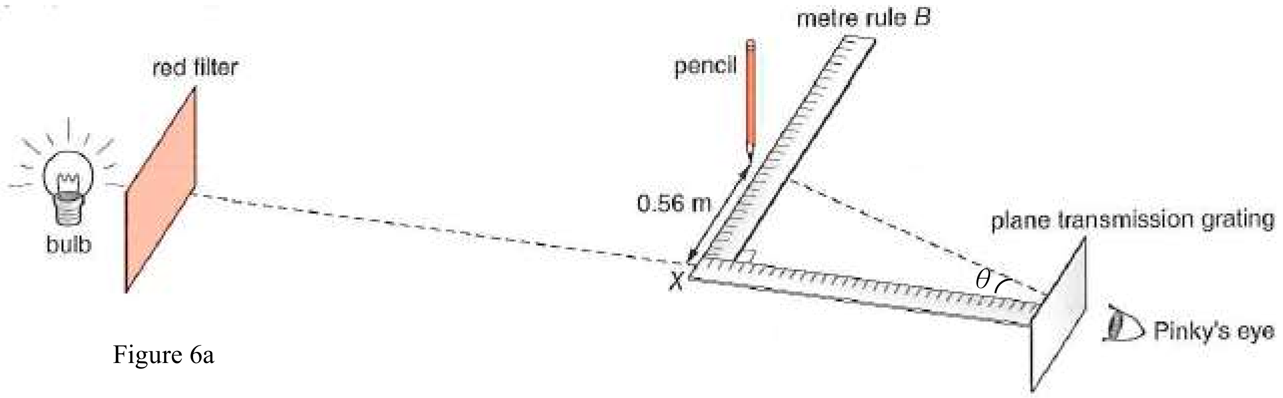

Figure 6a

Pinky asks Tracy to hold a pencil vertically at point *X*, where the pencil coincides with the central red fringe as seen through the grating. Then Tracy moves the pencil along rule B and is told to stop when the pencil coincides with the first red fringe. The distance between the position where the pencil stops and point *X* is 0.56 m, and the grating used has 700 lines per mm.

(a) Calculate the diffraction angle θ . (1 mark)

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(b) Hence find the wavelength of the red light. (3 marks)

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(c) If the red filter is removed, some multiple-colored fringes formed shown in Figure 6b. Indicate the colors of the ends of fringe *A* on the space provided. (2 marks)

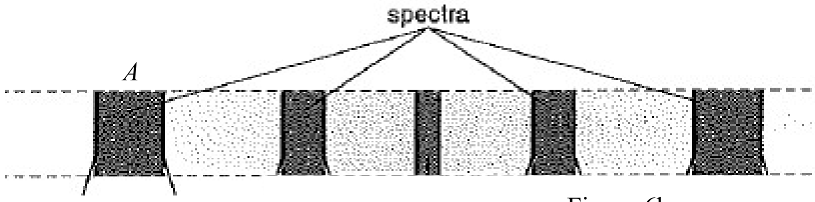

Figure 6b

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7. A double slit is set up in a ripple tank by straight barriers as shown below. At time $t = 0$, a plane wave reaches the double slit normally. An interference pattern is then observed. The period and wavelength of the wave are respectively 0.06 s and 3 cm.

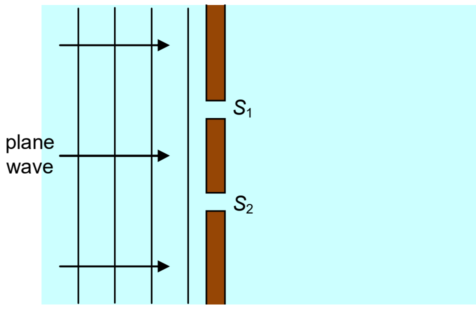

Figure 7a

(a) There is a point P in the interference pattern at which the displacement of the particle is constantly zero. Explain why the particle's displacement remains zero. (2 marks)

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(b) Consider a point Q in the ripple tank as shown in Figure 6b below.

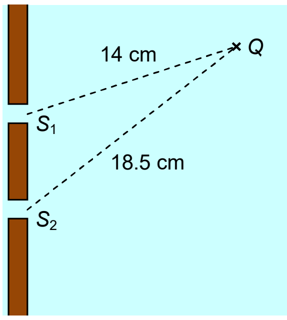

Figure 7b

(i) Determine the type of interference occurring at point Q. (2 marks)

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(ii) Find the time taken for the wave to travel from S_1 to Q. (3 marks)

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(iii) Sketch the displacement–time graph of the particle at Q in the time between $t = 0$ and $t = 0.4$ s. (2 marks)

8. Figure 8 shows an evacuated chamber with a slit *C*. *A* and *B* are deflecting plates which set up a uniform electric field of strength 1.5×10^5 N C^{-1} between them. A uniform magnetic field of flux density 0.1 T is applied perpendicularly out of the paper and throughout the whole chamber region as shown. A proton of mass 1.67×10^{-27} kg and charge 1.6×10^{-19} C passes straight through *C*.

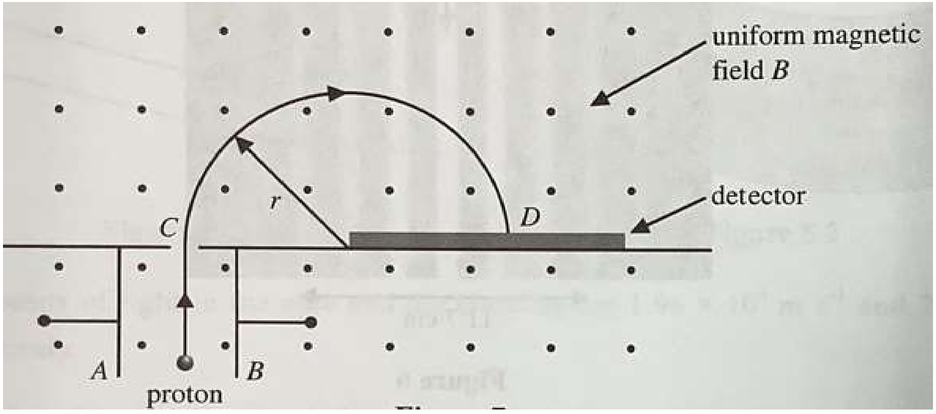

Figure 8

(a) The proton travels between the deflecting plates *A* and *B* along a straight line.

(i) What is the direction of the electric field between plates *A* and *B*, from *A* to *B* or *B* to *A*? (1 mark)

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*(ii) Find the speed with which the proton passes through *C*. (2 marks)

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*(b) (i) After leaving slit *C*, the proton moves in a semi-circular path of radius *r* and then strikes the detector at point *D*. Find the distance between *C* and *D*. (3 marks)

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(ii) An unknown particle *X*, which has the same charge as the proton, passes through *C* at the same speed of the proton as found in (a)(ii). If the particle strikes the detector 0.8 μs after passing through *C*, estimate the mass of particle *X*. (3 marks)

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9. An electrical cable contains 20 copper wires, each of which is 6.0 m long. The cross-sectional area of each wire is 3.4×10^{-9} m^2. The resistivity of copper is 1.7×10^{-8} Ω m.

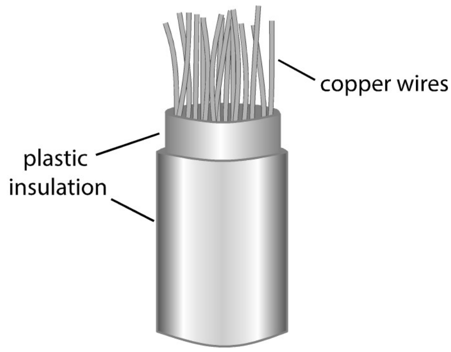

Figure 9a

(a) Find the resistance of the cable. (2 marks)

*(b) Two such cables are used to connect a '12 V, 24 W' lamp to a 12 V a.c. source of negligible internal resistance as shown.

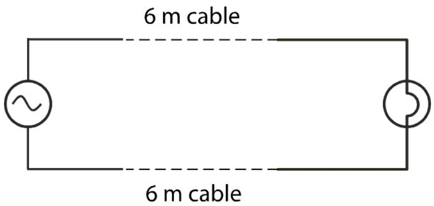

Figure 9b

(i) Find the power dissipated by the lamp. Assume that its resistance is a constant. (3 marks)

(ii) Find the power loss in the two cables. (2 marks) *(c) In order to operate the lamp at its rated power, a power transmission system with two ideal transformers is now used. The first transformer has 100 turns in the primary coil and N turns in the secondary coil. The second transformer has 500 turns in the primary coil and 100 turns in the secondary coil. Now, the lamp works at its rated values.

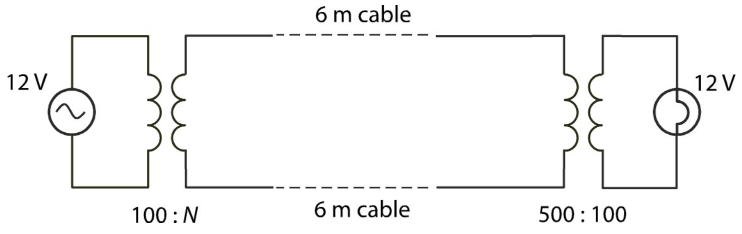

Figure 9c

(i) Find the primary voltage V_2 of the step-down transformer. (2 marks)

(ii) Find the current flowing through the cables. Hence, find the power loss in the two cables. (2 marks)

(iii) Find N. (3 marks)

10. The following apparatus are provided for investigating the relationship between the acceleration and the mass of an object:

- a 1-kg trolley with built-in motion sensor
- an elastic thread
- a friction-compensated runway
- two 0.5-kg mass bars

(a) Describe the procedures of the experiment. State the physical quantities to be recorded. Write down ONE precaution of the experiment for getting a more accurate result. (4 marks)

(b) Suggest a reason for using the friction-compensated runway. (1 mark)

(c) What is the relationship between the acceleration a and the total mass m of the trolley? (1 mark)

11. In the reactor of the Daya Bay Nuclear Power Station, the following reaction takes place:

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{142}_{56}\text{Ba} + ^{91}_{36}\text{Kr} + 3\,^{1}_{0}\text{n} + 2.79 \times 10^{-11}\ \text{J}$$

Given: mass of $^{91}_{36}\text{Kr}$ = 90.923 u, mass of $^{142}_{56}\text{Ba}$ = 141.916 u, mass of $^{235}_{92}\text{U}$ = 235.044 u

(a) (i) Find the loss in total mass after the reaction in kg. (2 marks)

(ii) Hence, estimate the mass of a neutron in atomic mass units. (3 marks)

(b) The fuel in the reactor contains 1.0×10^4 kg of U-235.

(i) How many U-235 atoms does the fuel contain? (2 marks)

(ii) Hence, find the total energy released by the U-235 in the fuel if all the U-235 nuclei undergo the above fission completely. (1 mark)

END OF SECTION B

END OF PAPER