PO LEUNG KUK TANG YUK TIEN COLLEGE
MOCK EXAMINATION (19/20)

Form	: 6	Date	: Feb 03, 2020
Subject	: Physics	Time	: 08:30 - 11:00
Paper	: IB	Class	:___________(____)
Full Mark	: 84 (Section B)	Name	: ________________

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

1 Follow the instructions given in the announcement before the start of the examination. You should write your Name, Class and Class number in the spaces provided on this page.

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 paper and supplementary answer sheets will be supplied on request. Write your Name, Class and Class number on each sheet and fasten them with string **INSIDE** this Question-Answer book.

6 No extra time will be given to candidates for filling in their personal information after the ‘Time is up’ announcement.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
/8	/6	/9	/8	/5	/10	/9	/9	/12	/8

Grand Total: ___________ /84

Answer **ALL** questions. Write your answers in the spaces provided.

1. Figure 1.1 shows the set-up of an experiment for finding the specific heat capacity *c* of a liquid. A glass tube containing a heating coil is fitted into a vacuum container. The liquid is pumped into the glass tube and heated by the coil. The mass of liquid passing through the tube in one second is *m*. The voltage *V* across the coil and the current *I* passing through the coil are adjusted so that the temperature difference $T_2 - T_1$ is small but measureable.

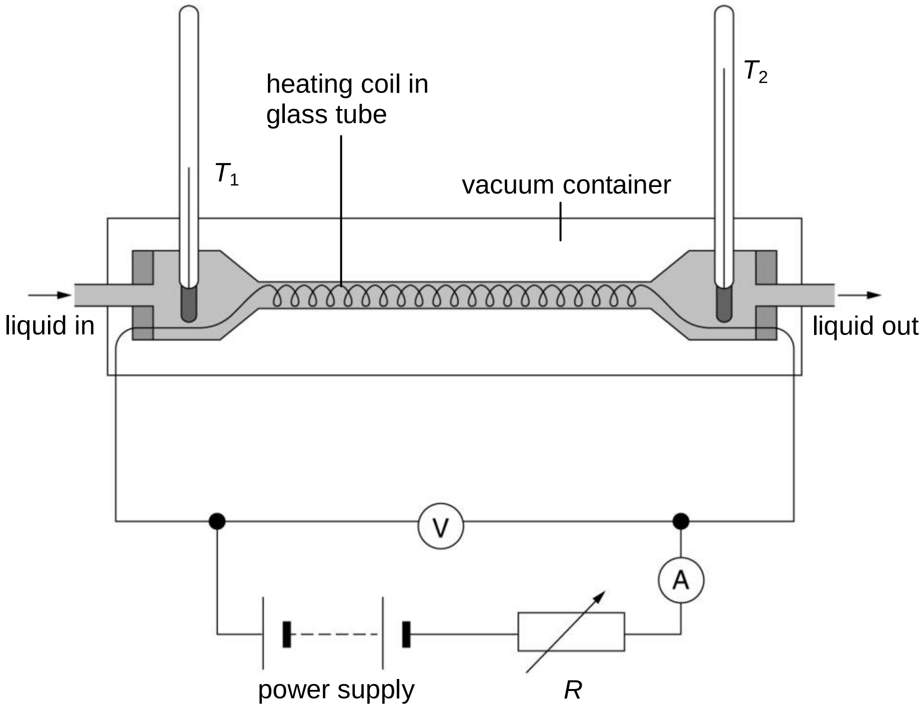

Figure 1.1

The following table shows the result obtained from the experiment.

I	2.0 A
V	50 V
m	0.01 kg
T_1	25 ℃
T_2	30 ℃

(a) What is the use of the vacuum container? (1 mark)

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(b) Find the energy supplied to the liquid by the heating coil in one second.(2 marks)

(c) Assume the energy lost to the surroundings is negligible. Using the result in **(b)**, find the specific heat capacity of the liquid. (3 marks)

(d) Suggest a way by which energy is lost from the set-up to the surroundings.(1 mark)

(e) The flow rate of liquid is slightly reduced. How should the variable resistor *R* be adjusted so that the temperature difference $T_2 - T_1$ remains unchanged?(1 mark)

2. A weather balloon filled with 0.656 kg of helium gas occupies a volume of 4 m^3. It is released at ground level and moves up into the sky (Figure 2.1). It carries a device for measuring the air temperature T and the atmospheric pressure P at different heights above the ground.

Figure 2.1

(a) After data are collected from the device, a graph that shows the relationship between $\frac{P}{T}$ and height is plotted (Figure 2.2).

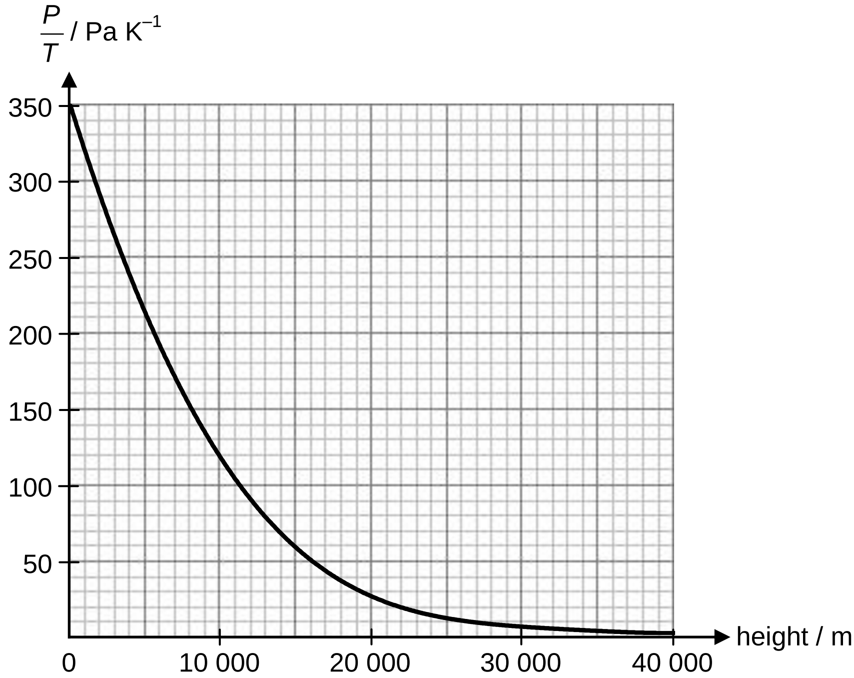

Figure 2.2

Describe how the volume of the balloon changes when it moves up. Assume the pressure and the temperature of the helium gas are the same as those of air at the same height. (1 mark)

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(b) The balloon will burst when its volume reaches 35 m^3. Find the maximum height the balloon can reach. (3 marks)

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(c) Just before the balloon bursts, the temperature of the helium gas is –56 °C. Find the root-mean-square speed of the helium molecules. (2 marks)

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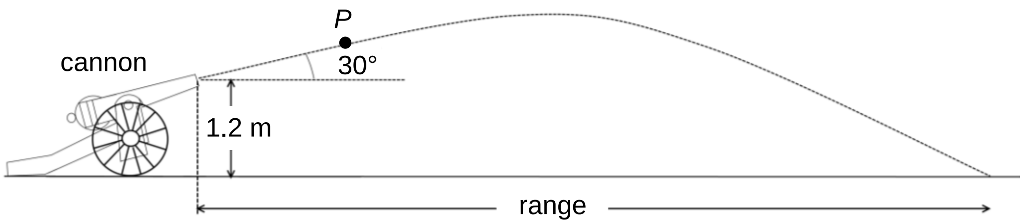


Figure 3.1

In Figure 3.1, a cannon fires a cannonball at an angle of 30° to the horizontal. The cannon and the cannonball are of mass 500 kg and 5.5 kg respectively. When the cannonball is fired, the cannon moves 0.3 m backwards in 0.4 s. Neglect air resistance and assume the friction between the cannon and the ground is a constant. Ignore the length of the cannon tube.

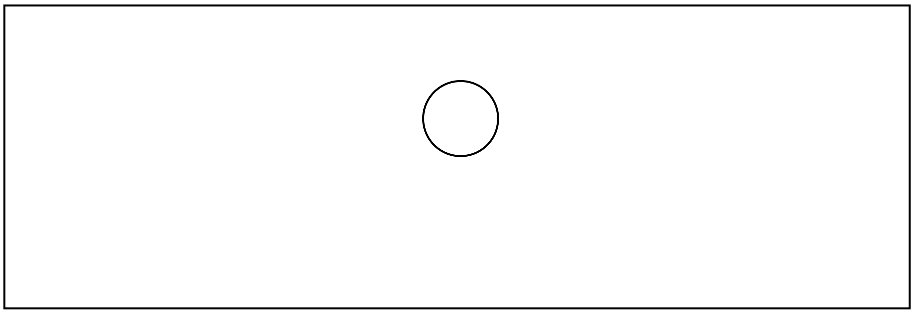
(a) **(i)** Find the recoil speed of the cannon at the instant when the cannonball just leaves the cannon. (2 marks)

(ii) Find the horizontal speed of the cannonball when it just leaves the cannon. (2 marks)

(b) The cannonball leaves the cannon at a height of 1.2 m above the ground.

(i) Find the vertical speed of the cannonball when it leaves the cannon.(1 mark)

(ii) Draw the free-body diagram of the cannonball in the space provided when the cannonball is at point *P*. (1 mark)



(iii) Find the range of the cannonball. (3 marks)

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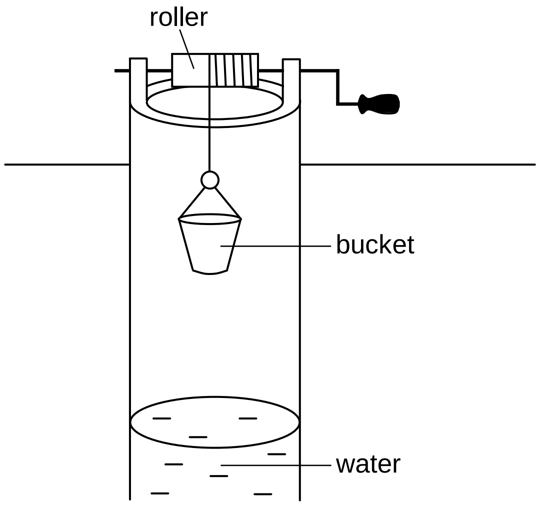


Figure 4.1

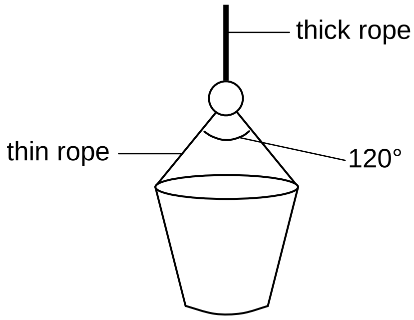


Figure 4.2

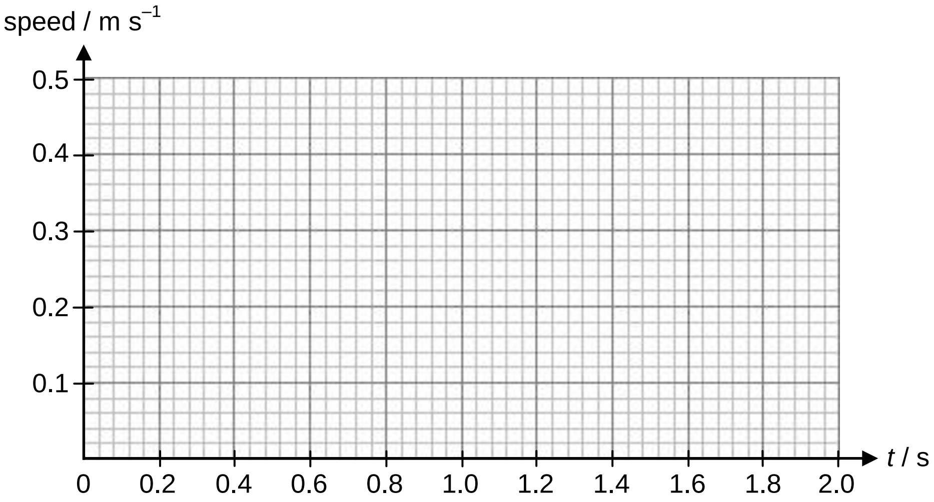
A rope and bucket system can be used to draw water from a well (Figure 4.1). Two thin ropes subtending an angle of 120° are attached to the bucket, and they are connected to a roller by a thick rope (Figure 4.2). The mass of the bucket is 1.2 kg. Neglect the mass of the ropes.

(a) The bucket is filled with 15 kg of water and is held stationary above the water surface. Find the tension of each of the thin ropes. (2 marks)

(b) At time $t = 0$, the bucket of water in **(a)** is lifted up from rest with an acceleration of 0.2 m s^{-2} for 1.5 s and a constant speed afterwards.

(i) Find the tension of the thick rope when the bucket of water is accelerating upwards. (2 marks)

(ii) Sketch the variation of the speed of the bucket from t = 0 to 2 s on the graph paper below. (2 marks)



(iii) Find the power provided by the person who is lifting the bucket of water when the bucket is rising at a constant speed. (2 marks)

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5. Figure 5.1 shows a smooth sloping track *ABC* firmly fixed in a vertical plane with its horizontal part *BC* resting on a bench surface. You are given a toy skier, a metre rule and a long rough paper strip with adhesive tape on the bottom surface.

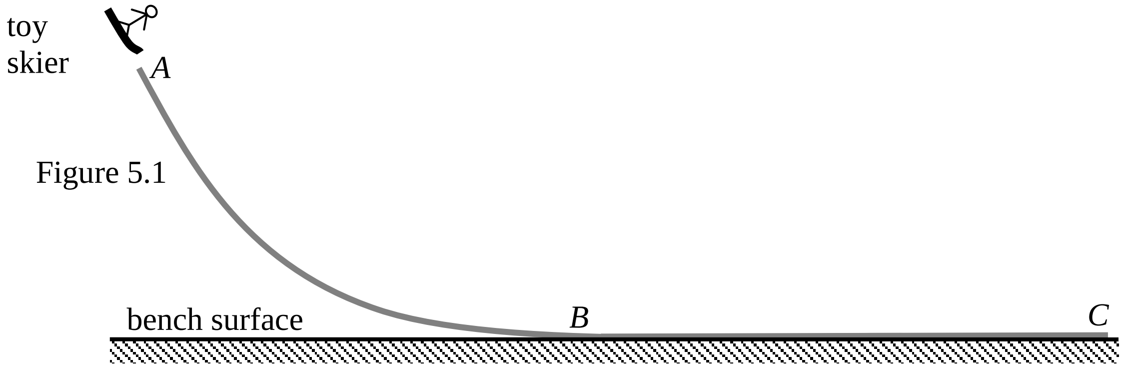

Figure 5.1

Using the apparatus provided, describe an experiment to study how the stopping distance of the toy skier depends on its height of release. Your description should include the physical quantities to be measured and the result expected. (5 marks)

6. **(a)** A coin is placed at the bottom of a beaker of water. Figure 6.1 shows two rays of light reflected by the coin reaching the water surface. A student observes the coin from above.

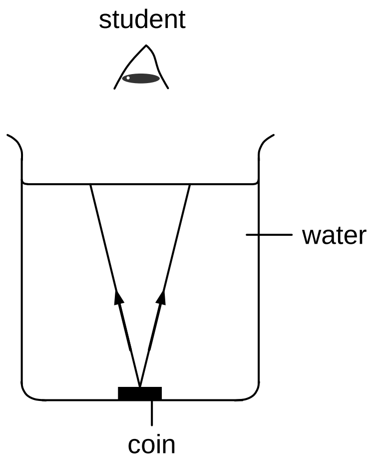

Figure 6.1

(i) Complete the paths of the light rays in Figure 6.1 to show how they travel after passing through the water surface. Hence, locate the image of the coin as observed by the student. (3 marks)

(ii) Now, the water in the beaker is replaced by a liquid with a lower refractive index. Explain how the position of the image of the coin changes as observed by the student. (2 marks)

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(b) In Figure 6.2, an object is placed in front of a lens (not shown). The magnification of the image is $\frac{2}{3}$.

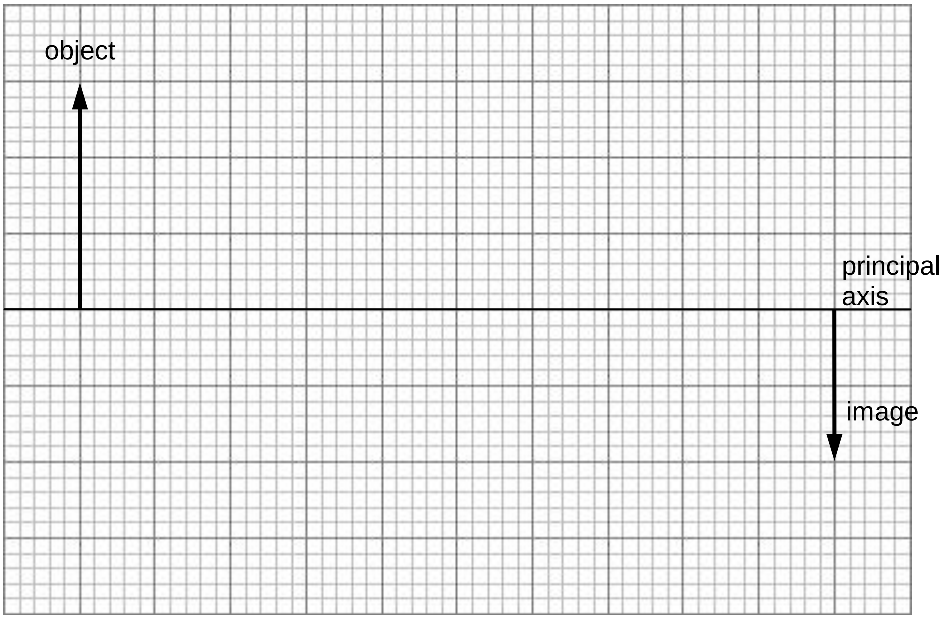

Figure 6.2

(i) What is the type of lens? Explain briefly. (2 marks)

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(ii) Add light rays in Figure 6.2 to locate the position of the lens and its two foci. Label the two foci with *F* and *F'*. (3 marks)

7. Figure 7.1 shows the set-up of a double-slit experiment. The screen is 1 m away from the double-slit of slit separation 0.3 mm. A monochromatic red light source with a frequency of 4×10^{14} Hz is used.

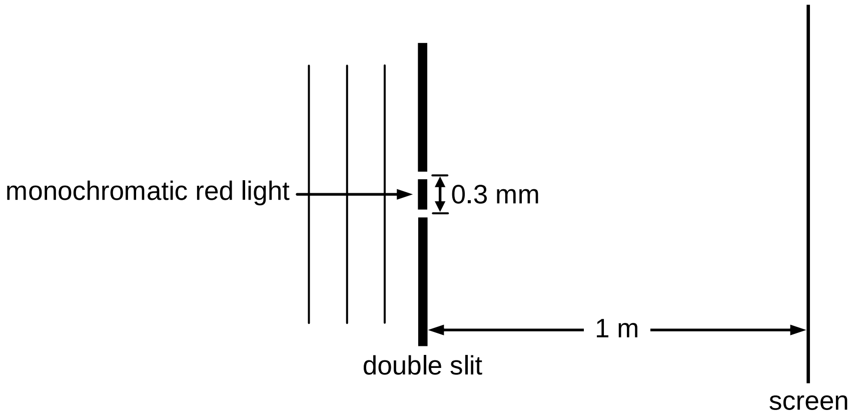

Figure 7.1

In the experiment, an interference pattern (Figure 7.2) is formed on the screen.

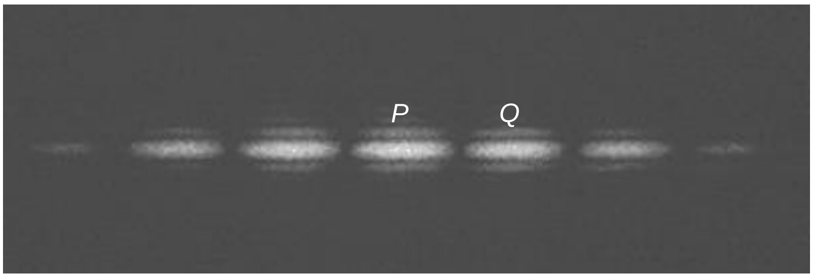

Figure 7.2

P is the bright fringe at the centre of the interference pattern and *Q* is a bright fringe on its right.

(a) **(i)** Determine the types of interference at the centres of fringes *P* and *Q*. (2 marks)

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(ii) Find the path differences at the centres of fringes *P* and *Q* in terms of the red light's wavelength λ. (2 marks)

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(b) Find the wavelength of the monochromatic red light. (2 marks)

(c) How will the fringe separation change if the red light source is replaced with a monochromatic blue light source of wavelength 450 nm? (1 mark)

(d) Write down TWO precautions that should be taken when carrying out the above experiment. (2 marks)

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8. Figure 8.1 shows a stadium light post with nine lamps connected in parallel. Each lamp is rated at '220 V, 1000 W'. Several identical light posts are then connected in parallel in a lighting circuit. The lighting circuit is then connected to the 220-V mains via a 240-m cable.

Figure 8.1

(a) Find the resistance of a single lamp and the resistance of the stadium light post when the lamps on it are operated at their rated value. (4 marks)

(b) If the cable connecting the lighting circuit to the mains has a cross section area of 2.5 mm^2 and its resistivity is 1.7×10^{-8} Ω m, find the resistance of the cable.(2 marks)

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(c) How many light post at most can be connected in a lighting circuit if the circuit breaker for the lighting circuit is rated at 70 A? Assume that the resistance of each lamp is the same as the value found in (a). (2 marks)

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(d) Explain why the power consumption of the lamps on the light posts are not the same as their rated value. (1 mark)

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9. Read the following description about a **Faraday flashlight** and answer the questions that follow.

Faraday flashlight, or 'shake flashlight', as shown below is a type of mechanically powered flashlight.

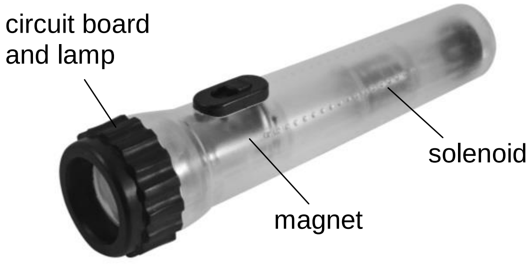

Figure 9.1

The flashlight has a generator which charges a rechargeable battery when the flashlight is shaken lengthwise. The battery is then used to power a lamp. The generator consists of a sliding permanent magnet which can move back and forth through a solenoid when the flashlight is shaken. A current is induced in the loops of wire each time the magnet passes through the solenoid. As a result, the battery is charged. A vigorously shaking of the flashlight for about 30 seconds can provide up to 5 minutes of light.

Figure 9.2 shows the circuit of the flashlight. Current is only allowed to flow through a diode in the same direction as the arrow in the diode symbol indicated.

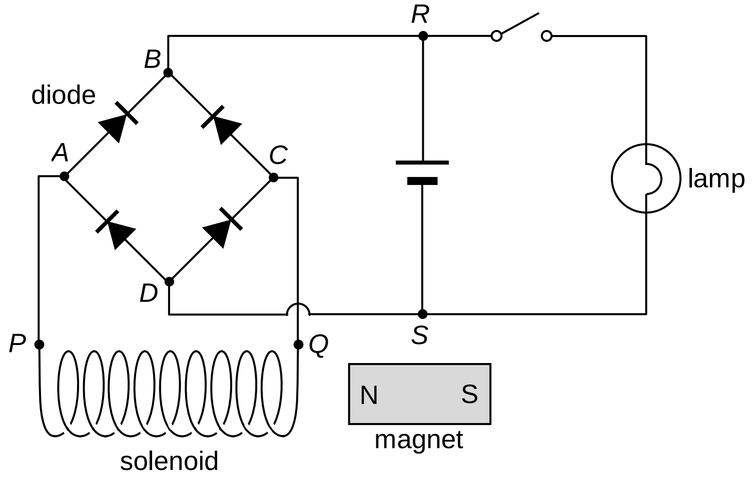

Figure 9.2

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(a) The magnet in Figure 9.2 is passing through the solenoid. It approaches the solenoid from the right, moves inside the solenoid and leaves the solenoid completely from the left. Describe the direction of the induced current in the solenoid in the whole process. (3 marks)

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(b) Refer to Figure 9.2. When the current flows through the circuit outside the solenoid in the following directions, write down the sequence of the points that the current flows through.

(i) *P* to *Q* (1 mark)

$P \rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow Q$

(ii) *Q* to *P* (1 mark)

$Q \rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow$ ___ $\rightarrow P$

(c) The specification of the shake flashlight in Figure 9.1 is shown below:

Power dissipation by the lamp = 100 mW
Number of turns of solenoid = 330
Maximum change in magnetic flux through a coil of the solenoid in vigorous shaking = 0.0133 Wb s^{-1}

(i) Estimate the average power of the generator inside the flashlight when the flashlight is being shaken vigorously. Assume that there is no energy loss in charging the battery. (2 marks)

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(ii) Will the lamp become brighter if the flashlight is shaken more vigorously? Why? (2 marks)

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****(iii)** Assume that the induced e.m.f. in the solenoid is a sinusoidal a.c. Estimate the magnitude of the peak value and hence the r.m.s. value of the induced e.m.f. (3 marks)

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10. Americium-241 ($^{241}_{95}\text{Am}$) is used as the radioactive source inside a smoke detector as shown in Figure 10.1. It undergoes α decay to become neptunium (Np). The α particles emitted ionize the air molecules between the conducting plates. The positive ions and negative electrons formed are attracted to the two oppositely charged plates. This creates a flow of current between the plates.

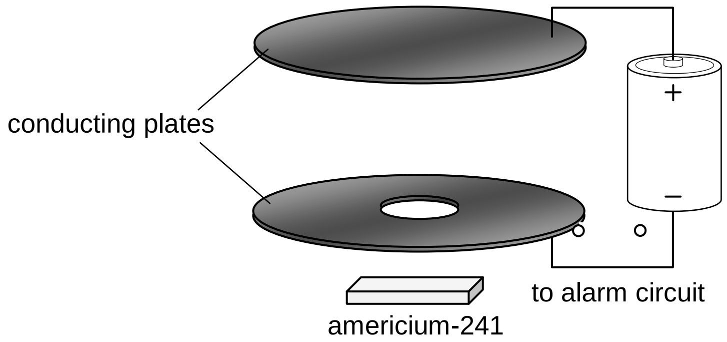

Figure 10.1

(a) Draw an arrow in Figure 10.1 to indicate the direction of the electric field between the plates. Label it as *E*. (1 mark)

(b) Write down the equation for the alpha decay of $^{241}_{95}\text{Am}$. (2 marks)

(c) Smoke particles are usually positively charged. Briefly explain how the smoke alarm is triggered when smoke particles are presented inside the smoker detector. (2 marks)

(d) A typical new detector contains $^{241}_{95}\text{Am}$ of activity of 3.33×10^4 Bq. Find the activity of the $^{241}_{95}\text{Am}$ after the detector is used for 10 years. The half-life of $^{241}_{95}\text{Am}$ is 432 years. (3 marks)

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