

**Useful Formulae in Physics**

- (a) Relationships between initial velocity u , uniform acceleration a , final velocity v and displacement traveled s after time t .

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

- (b) Potential energy gained by a body of mass m when raised through a height h is mgh .

- (c) Kinetic energy of a body of mass m moving with speed v is $\frac{1}{2}mv^2$

- (d) Power = Force \times Velocity

- (e) Equivalent resistance of two resistors R_1 and R_2 .

(i) in series = $R_1 + R_2$

(ii) in parallel = $\frac{R_1 R_2}{R_1 + R_2}$

- (f) Power = Potential different \times Current



1. A pot and a glass of hot tea are shown below.



- (a) The glass of hot tea will gradually cool down. Explain the reasons why it cools down.

(4 marks)

- (b) Suggest some methods to reduce the rate of heat lost by the processes mentioned above.

(3 marks)

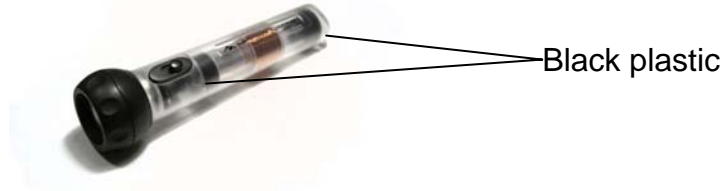
- (c) State the reason why the pot is white in colour.

(1 mark)



2.

The following diagram shows a human powered torch, which is invented in 2002.



The main components of the torch are a light bulb, a special rechargeable battery, and an electrical generator, including a magnet and a solenoid.

When the torch is shook forwards and backwards, the magnet moves to and fro across the solenoid, electromotive force and current are induced. The electromotive force is then charge up the special rechargeable battery and it is stored temporarily. Finally, if you close the switch, the circuit will be completed and the light bulb will light up. According to the informal statistical data, continuously shaking for 30 seconds can charge up the battery for 5 minutes use.

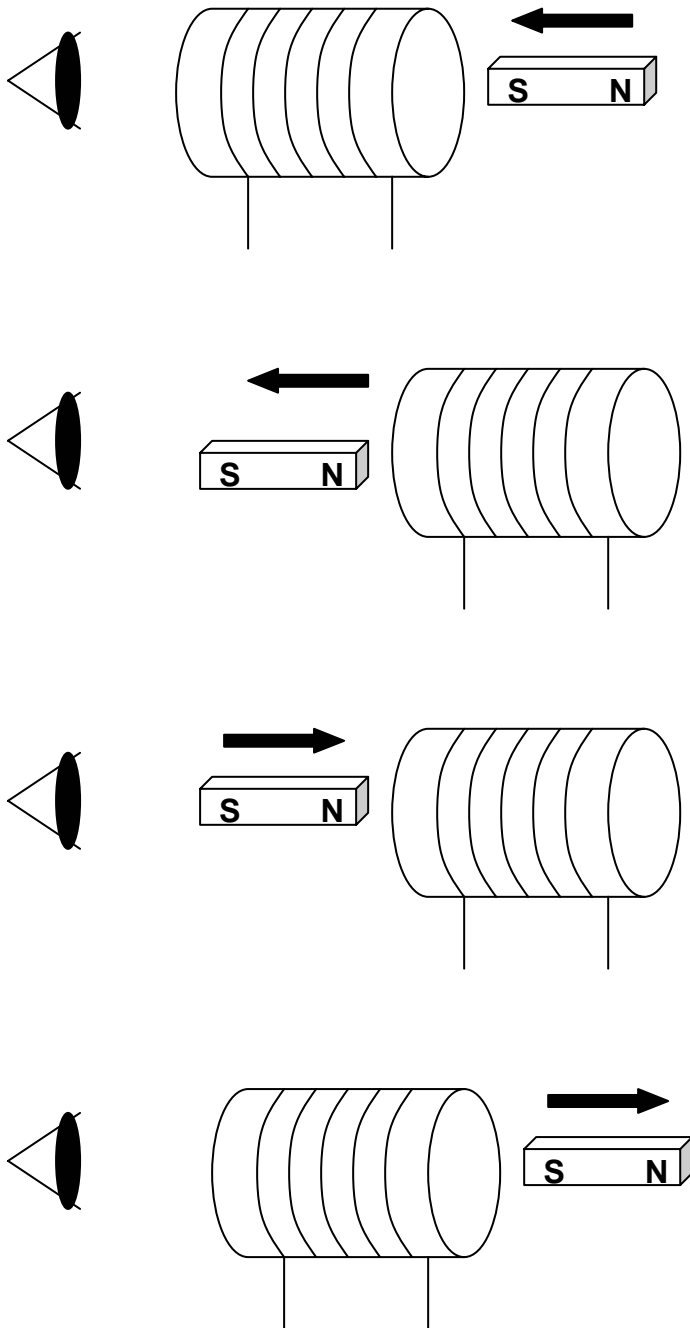
Other than conserving the environment by using less chemical cells and less coal drive electricity, this torch can also use in a disaster that makes electricity unavailable.

(a) What is the use of the black plastics?

(2 marks)

(b) The following diagrams show how the current is induced. Mark with arrows on the diagrams showing the directions of currents.

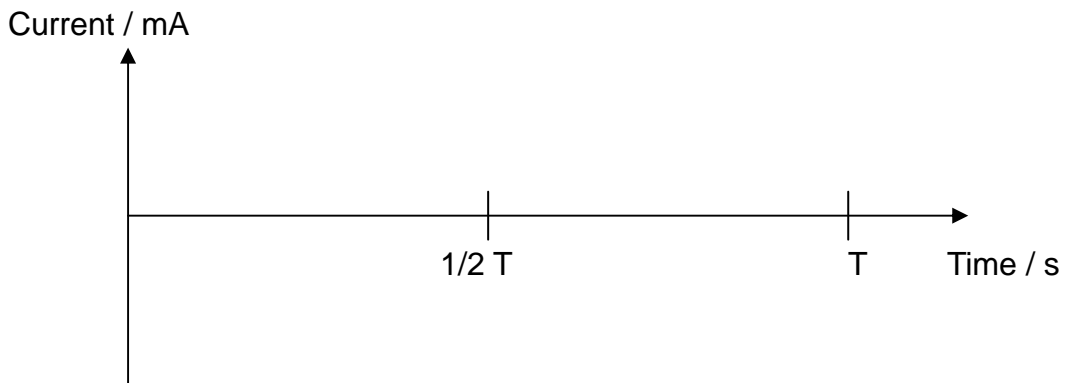
(4 marks)





(c) Sketch on the following graph, showing the current against time. You may consider the clockwise direction as positive.

(2 marks)



(d) Suggest 1 kind of disaster that makes electricity unavailable and, hence, this kind of torch will be especially useful.

(1 mark)

(e) In order for the light to transmit further, there is a lens place in front of the light bulb. Suggest what kind of lens should be used and where should the light bulb place relative to the lens.

(2 marks)



3.

The table shows the description of an energy saving light bulb and a Tungsten lamp.

Energy Saving Light Bulb	Tungsten (鎢) Lamp
	
<p>Detailed Product Description</p> <ol style="list-style-type: none"> 1) Power: 15 W 2) Voltage: 220 V 3) Life: 6000 hours 4) Price: \$ 56 5) Up to 90% energy saving 6) Equivalent to tungsten light bulb of 60 W 	<p>Detailed Product Description</p> <ol style="list-style-type: none"> 1) Power: 60 W 2) Voltage: 220 V 3) Life: 600 hours 4) Price: \$ 8

a) Calculate the efficiency of the tungsten lamp. Suggest a way that the other percentage of energy goes.

(2 marks)

b) Calculate the total energy output for both lamps within their maximum life span.

(3 marks)



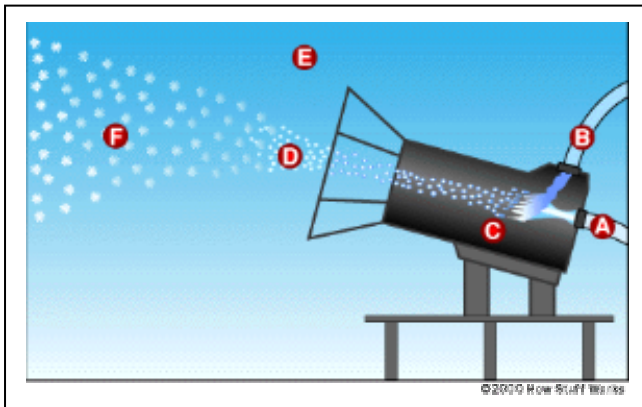
- c) Which bulb is more economic to buy in terms of cost per unit effective energy output? Explain briefly.

(4 marks)



4.

Amanda went to an arcade call “Snow Paradise” to experience the “real snow” in Hong Kong. However, the “snow” is actually some water. Winston also went to the same arcade, and really experienced the “real snow”. They try to find out why they had such different experience. The following is some information about Snow-Making machines that they found.



A) Air, B) Water, C) Cutting water into droplets, D) Droplets from ice crystals

E) Air at -1 °C, F) Snow

The above diagrams show how Snow-Making machines works. However, Snow-Making machines do not make snow under any conditions.

Water cools itself by evaporating some water as water vapour. This releases heat, lowers the energy level in the water and makes itself solidify. When there is more water vapour in the atmosphere, water or snow can't evaporate as much. Therefore, water cools more slowly when the humidity is high, and more quickly when the humidity is low.

Humidity is a very important factor in determining snow conditions. Even at the freezing temperature, you might get rain instead of snow because the water vapour saturation slows the cooling process down so much.

If the temperature is around -1 °C, you need a fairly low relative humidity (less than 30 percent) for good snow-making conditions. If the temperature is well below -6.7 °C, you can make snow fairly easily even if the relative humidity is 100 percent. This temperature is ideal for snow-making.

Adapt from <http://travel.howstuffworks.com/snow-maker.htm>



- (a) Suggest why Amanda can only experience some spraying water instead of snow.

(2 marks)

- (b) Even when the temperature is -1°C , a snow-making machine may not be able to make snow. Explain briefly.

(1 mark)

- (c) Name two processes of change of state of water occurred during snow-making.

(1 mark)

- (d) Explain why the snow can be made easily when the temperature of the atmosphere is well below -6.7°C .

(1 mark)



5.

The following diagram shows the internal structure of an air conditioner (Fig. A), its simplified system (Fig. B) and the outlook of an air-conditioner (Fig. C).

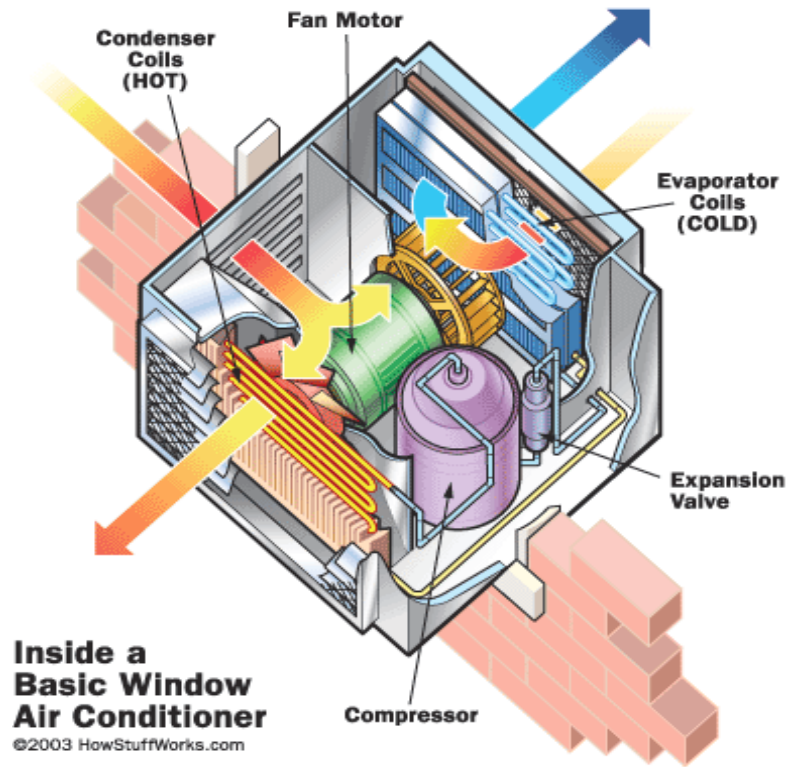
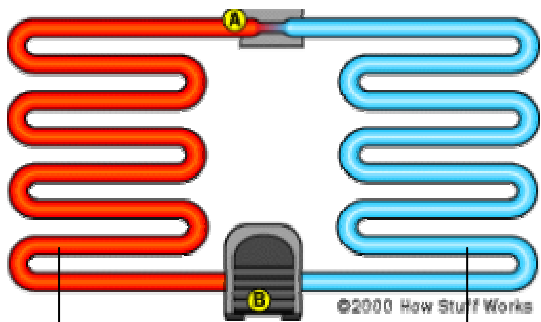


Fig. A



(A) Expansion value

(B) Compressor

Condenser

Evaporator

Fig. B



Fig. C

Source: <http://home.howstuffworks.com/ac2.htm>



A refrigerant, like Freon, is pumped through the compressor and the evaporator by circulating along the coiled tube as shown. It changes from liquid state to gas state at the evaporator and it changes from gas state to liquid state at the compressor and condenser.

- (a) Name the physical process that takes place in the condenser and evaporator.

(2 marks)

- (b) Draw some arrows on Fig. B to indicate the direction of the flow of Freon.

(1 mark)

- *(c) Explain briefly how the room can be cooled down, you should begin with the following sentence.

(5 marks)

The compressor compresses cool Freon gas, causing it to become hot, high-pressure Freon gas.

- (d) If the air-conditioner, which is 0.75 horsepower, mentioned above has installed in your bedroom, and you switch it on every night (in the summer) when you sleeps. Given that you sleeps eight hours a day, there are 31 days in August, 1 kilowatt hour electricity costs \$1.2 and 1 horsepower equals to 1000 W.

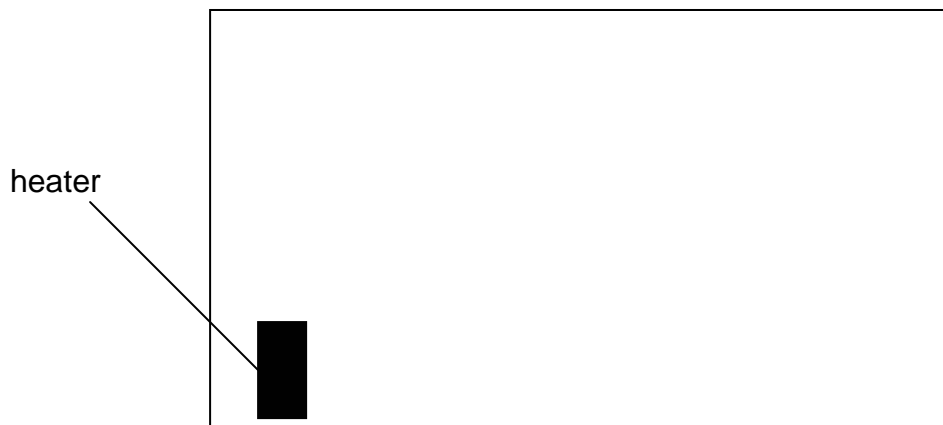
Calculate the electricity fee for that air-conditioner you need to pay during August.

(2 marks)



- (e) The diagram below is your bedroom. In winter, you will switch on the heater instead. Draw the direction of airflow in the room when the heater is on. Explain brief how it can make your bedroom warm.

(4 marks)





6.

CLP's proposed offshore wind study

A full scale feasibility study on the proposed offshore wind study at a site in Hong Kong's South Eastern Waters identified by an earlier pre-feasibility exercise began in 2005. The target date for completion of this feasibility study is 2008.

Location

Selection of the site is one of the most important factors in the development of the wind farm project - both to ensure its success as a platform for generating clean electricity and to strike a balance between economic, technical and environmental consideration.

Physical Location: Mean wind speed, water depth, seabed characteristics, sub-surface geology, coastal processes, seascape and landscape assessment.

Biological Environment: Protected areas, habitat type and character, marine park and marine life (benthos, fish, bird, mammals, etc.).

Human Environment: Electrical infrastructure, economic development opportunities, tourism / leisure, archaeology, navigation (shipping lanes, fairways, anchorage areas), fisheries, dumping grounds, port facilities, civil and military aviation industry, radar facilities.

Performance: Turbine spacing, array alignment, turbine selection and infrastructure optimization

South Eastern Waters

Through detailed study of different constraints, Hong Kong's South Eastern Waters were chosen as the most suitable site. Not only does this area avoid most potentially sensitive issues, but based on data from the Hong Kong Observatory, it is anticipated to be among the best wind resource offshore sites in Hong Kong.



<https://www.clpgroup.com/SocNEnv/Env/RenewEngy/WindPower/ProposedOfshore/Pages/windstudy.aspx?lang=en>

(a) What kind of current (a.c. or d.c.) will the output current be?

(1 mark)

* (b) Do you agree on implementing wind power in Hong Kong? Give reasons to support.

(5 marks)



7.

Flashover (閃燃) – The KILLER of firefighters

When all surface and objects with a close area heats to an “ignition temperature” (i.e. 500 °C), almost all the objects and the surfaces break up flame immediately. This is called a flashover.



Source: <http://www.firetactics.com/FIREFIGHTER'S-GUIDE.htm>

Suppose that objects indoor is burnt, the following are the three stages for flashover:

Stage One:

The fire on the objects produce hot smoke which rises up to the ceiling in that area.

Stage two:

The heat from the ceiling causes the ceiling and other surface to give off flammable gases. This is called pyrolysis.

Stage three:

When the surface temperatures of objects become very high, they further burn and make every corners in the room on fire in a very short moment.

To fight against the fire, "you should not pour a large amount of water to the burning objects, instead, you need to spray small burst of water to the hot flammable gases", A firefighter said.

Reference:



<http://en.wikipedia.org/wiki/Flashover>

<http://www.workingfire.net/misc3.htm>

http://www.bookrags.com/wiki/Fire_fighting

www.tforensic.com.au/docs/uts/essay3.pdf

<http://www.local1259iaff.org/flashover.html>

<http://www.firetactics.com/FIREFIGHTER'S-GUIDE.htm>

<http://www.firetactics.com/FLASHOVER.htm>

<http://www.firetactics.com/TACTICAL-OBJECTIVES.htm>

- (a) Explain briefly why hot smokes rise up to the ceiling in stage one?
(2 marks)

- (b) In stage two, Explain whether conduction, convection or radiation is responsible for those phenomena. Explain briefly why other two transfer processes are less contributing to that stage.
(3 marks)

- (c) What is the purpose to spray water to the hot flammable gases?
(1 mark)

- (d) Give two reasons why the firefighters should not pour a large amount of water to the burning objects?
(4 marks)

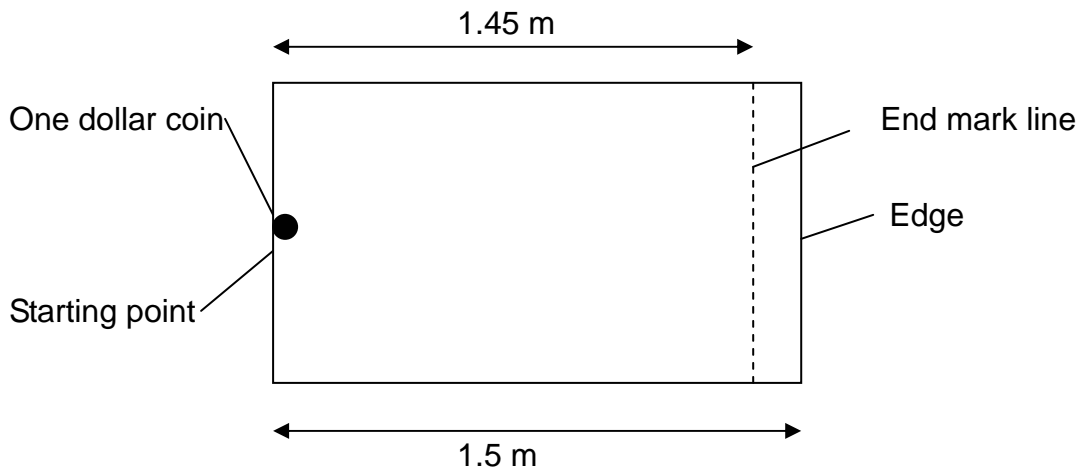


8.



A student is participating in a competition held by economic society called “sliding an one dollar coin in a table”. A little gift will be given if the coin is stopped between the end mark line and the edge. The following diagram is the top view of the table. Assume the coin is a point mass and the deceleration is 1.5 ms^{-2} , calculate the lowest range of the initial velocities.

(3 marks)





9.

Hoi Ying wants to find out her reaction. She asks her classmate to hold a straight ruler with marks vertically and the mark of zero is at the bottom. Hoi Ying brought her finger near the bottom of the ruler, without notification, the ruler is released by the classmate and Hoi Ying needs to catch the ruler as fast as she can.

The result shows the mark of ruler that Hoi Ying caught is _____ cm .

(a) Calculate Hoi Ying's reaction time.

(2 marks)

(b) If another heavier ruler is used for the above test, how should the result be affected? Explain briefly.

(2 marks)

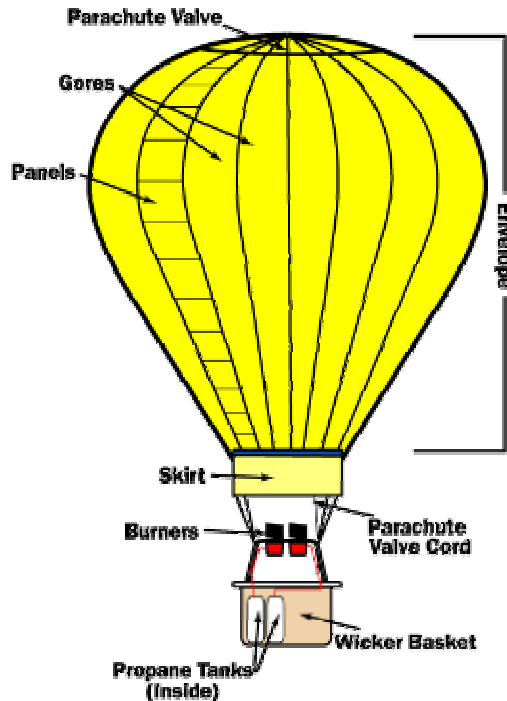
(c) State two conditions that the reaction time of Hoi Ying will be increased and, hence, make her not suitable for driving.

(2 marks)



10.

In New Zealand, riding hot air balloon to see the sunrise is very famous. The following diagram is the structure of a hot air balloon.



The masses of the components are as follow:

Envelope and Skirt	60 kg
Burners	40 kg altogether
Propane fuel tanks	90 kg altogether
Wicker (柳條) basket	25 kg
Two weights	25 kg each

Assume there is no air resistance and side wind. If two passengers, 60 kg and 50 kg, get into the basket,

(a) Calculate the lifting force of hot air in order to keep the balloon just above the ground.

(2 marks)



(b) The two weights are then released and the hot air balloon will then accelerate up. Calculate the acceleration.

(3 marks)

(c) After 7 second flight, the burners' flame will be reduced so that the balloon rises at a constant speed.

(i) Find the potential energy and kinetic energy of the system at that moment.

(4 marks)

(ii) As both the potential energy and kinetic energy are increasing, where does the energy come from?

(1 mark)

(d) If the balloon finally reaches 5 000m in order to get a good scenery, calculate the work done by the hot air to lift the balloon through 5 000m.

(3 marks)

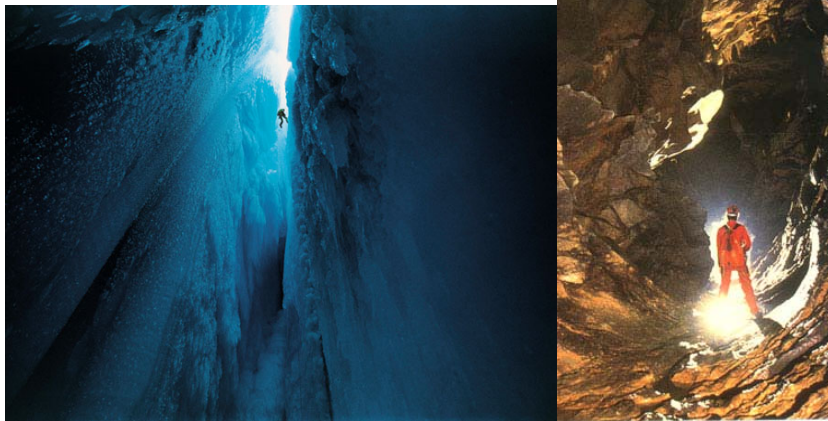


(e) Calculate the average power output by the burners to reach 5 000m. What assumption should be made in order to perform the calculation?

(4 marks)



11.



Jackie goes to Australia and finds a cave. He goes down and finds out the cave is quite deep. HT She thinks that if he only wants to find out the depth of the cave roughly, it is not necessary to go down and measure, instead, he can drop a stone down and listen to the rebound.

The following data are given:

Velocity of sound wave = 340 ms^{-1}

Time for the sound of rebound to be heard after dropping the stone = 5 s

Assume Jackie and the stone are point masses. Find out the depth of the cave.

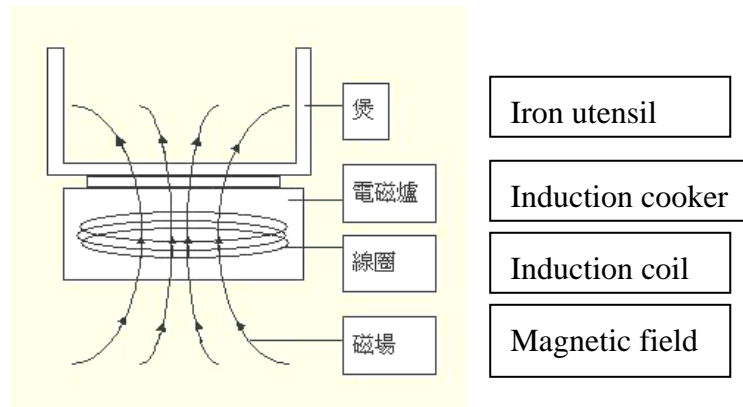
(4 marks)



12.



The above figure shows an induction cooker which uses induction heating for cooking. An iron utensil is placed above an induction coil for the heating process to take place.



When the induction cooker is turned on, an alternating current flows through the coil below the top plate. The above figure shows the main structure of the induction cooker, which converts electrical energy into internal energy of the cooking utensil.

(a) Describe the working principle of the induction cooker.

(3 marks)



(b) Explain briefly why an iron utensil is required to cook food by the induction cooker, but the copper cooking utensil is undesirable.

(4 marks)

(c) Can one use the clay pot to cook food by the induction cooker? Explain briefly.

(2 marks)

(d) Explain why the induction cooker can switch off automatically when no iron utensil is present.

(2 marks)

(e) The utensil contains 0.5 kg of water with an initial temperature of 25 °C. The temperature of the water rises to 55 °C in 0.5 minute. Find the useful average output power of the induction cooker.

(Given: Specific heat capacity of water = 4200 J kg⁻¹ °C⁻¹.) (2 marks)

(f) A family uses it to make hot pot and switches it on for 4 hours. If each unit of electricity costs \$0.9, what is the cost of electricity for using the cooker?

(2 marks)



(g) What happens to the heating effect of the cooker if

(i) the frequency of the a.c. is lowered;

(ii) coils with more turns are used?

(2 marks)

(h) Suggest one precaution when using an induction cooker

(1 mark)

(i) State **TWO** advantages of using induction cooker over electrical cooker in cooking food.

(2 marks)
