Anglican High School
Secondary Four
Preliminary Examination
2023

S4

CANDIDATE NAME

CLASS 4 ____ INDEX NUMBER ____

PHYSICS
Paper 2 Theory

6091/02
28 Aug 2023
1 hour 45 min

Candidates answer on the Question Paper.

No additional Materials are required.

	Marks
Section A	
Section B	
s.f. error	
Total (80)	

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all your work.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction tape.

Assessment noted by :

_____

Name of Parent/Guardian

_____

Signature of Parent/Guardian

Date : _____

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should be given to appropriate units and rounded off to the appropriate number of significant figures.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

This Question Paper consists of **18** printed pages including this cover page.

Section A

Answer **all** the questions in this section.

1 Ali throws an object vertically upwards from the top of his head. Fig. 1.1 shows the displacement-time graph of the motion of the object from the time it was released from the top of his head to the time it hits the ground.

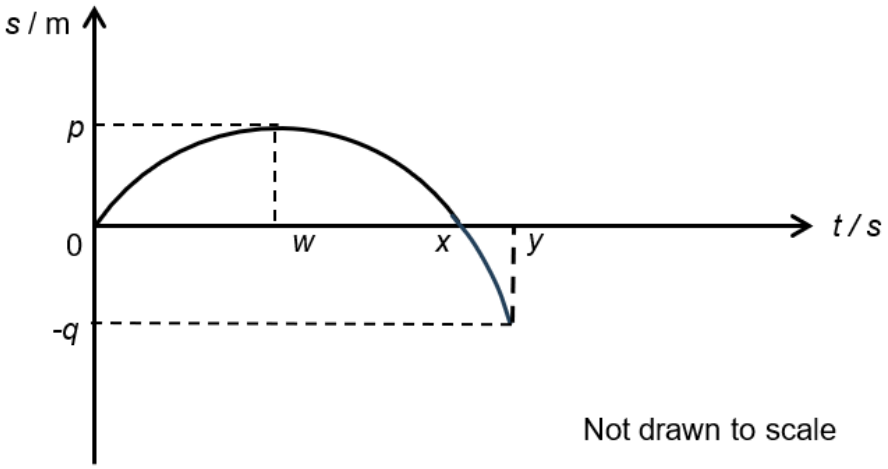


Fig. 1.1

(a) Describe the motion of the object from time t = w seconds to $t = y$ seconds in terms of its displacement and direction.

……

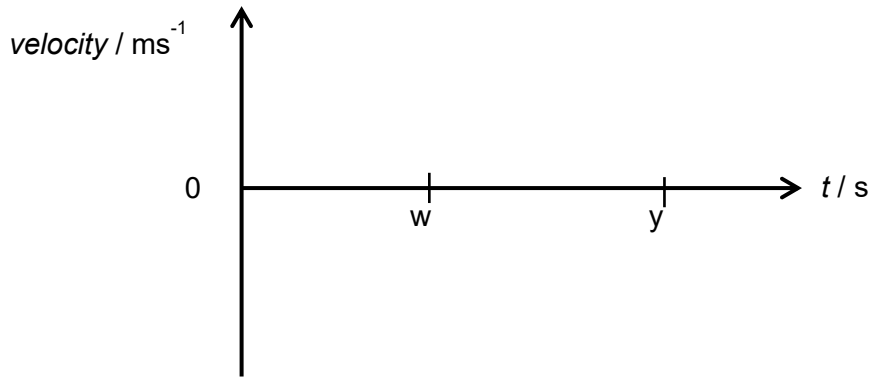
……

……

…… [2]

(b) Using a letter "H", mark and label a point in Fig. 1.1 which shows Ali's height. [1]

(c) In the space below, sketch a *velocity-time* graph of the object's full motion. Assume air resistance is negligible. Label the area under the graph corresponding to the distance travelled clearly with the letters p, q, and/or $p+q$. [3]



2 An object of mass *m* possesses gravitational potential energy when it is raised above a reference level in the gravitational field of the Earth.
Fig. 2.1 below represents the relationship between the gravitational potential energy E_P of an object and the vertical height *h* of the object above the reference level.
Take gravitational field strength as 10 N / kg.

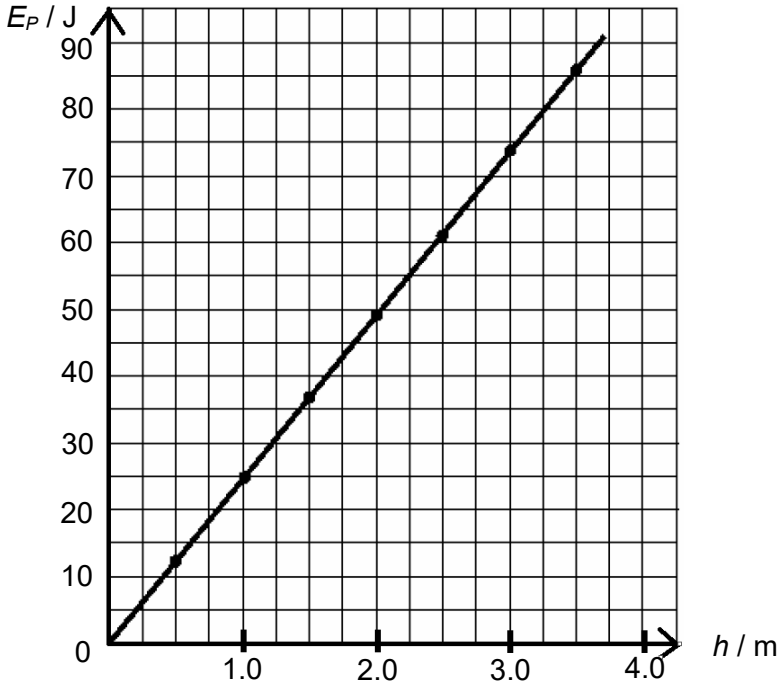


Fig. 2.1

(a) Using Fig. 2.1, write down the E_P of the object when it is 3.25 m above the reference level.

E_P = ……..... [1]

(b) **(i)** State the physical quantity represented by the gradient of the graph.

……..….. [1]

(ii) Draw another line on Fig. 2.1 to represent the relationship between E_p and *h* for another object that has a smaller mass. [1]

(c) The object placed at a height of 3.25 m above the reference level is then dropped from rest. Assuming that air resistance is negligible, calculate the speed of the object just before it reaches the ground.

speed = ……..... [2]

3 Fig. 3.1 shows a 0.60 kg mass hanging at rest from a spring.

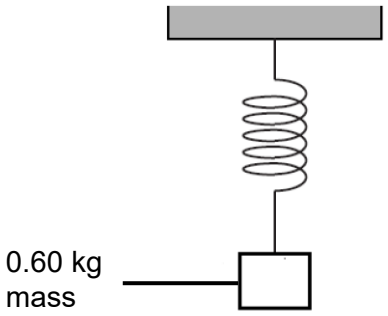


Fig. 3.1

(a) State what is meant by the *centre of gravity* of an object.

……

…… [1]

(b) There are two forces acting on the mass at this position. On Fig. 3.1, draw the two forces acting on the mass and write down the name of each of the force clearly next to each arrow. [2]

(c) The mass is pulled downwards and held at rest. Using ideas about forces, state and explain what happens to the upward force.

……

……

……

…… [2]

(d) The mass is now released. Using ideas about forces, state and explain the initial motion of the mass.

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……

……

……

…… [3]

4 Fig. 4.1 shows a hand-operated hydraulic press.

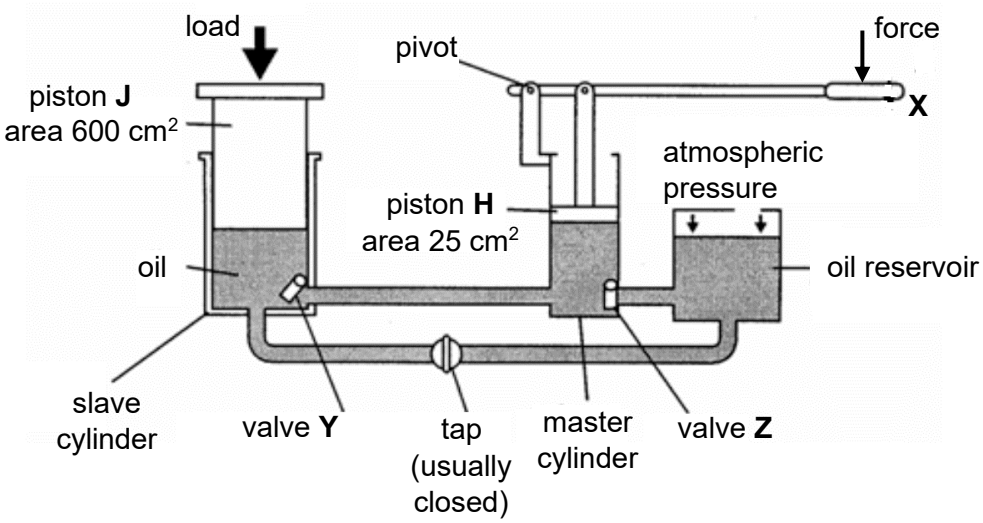


Fig. 4.1

A force is applied downwards at **X** as shown. When piston **H** moves downwards, valve **Z** closes and valve **Y** opens. Oil is forced through to raise piston **J** in the slave cylinder.

(a) Piston **H** exerts a force of 350 N on the oil.

(i) State what is meant by *pressure*.

..... [1]

(ii) Calculate the force exerted by the oil on piston **J**.

force = ……. [2]

(b) State the property of liquids that allows hydraulic systems to operate effectively.

..... [1]

(c) Piston **H** moves down 5.0 cm. Calculate the distance that piston J rises by.

distance = ……. [2]

5(a) Fig. 5.1 shows a very large plane mirror, inclined at 45° to the horizontal, beneath a painting on the high ceiling of a hall.

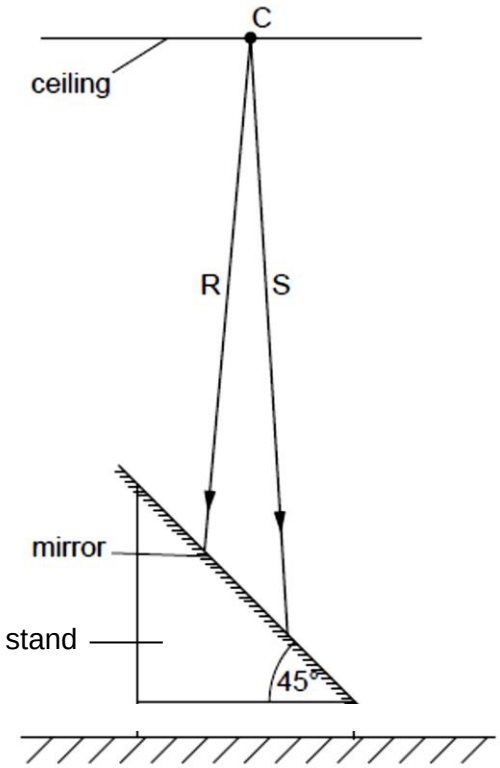


Fig. 5.1

The mirror is set on a stand at eye-level immediately below the centre C of the painting. This arrangement allows a person to see the painting on the ceiling at eye-level. R and S are two rays of light from C that strike the mirror.

On Fig. 5.1

(i) draw the normal at the point of incidence for ray S and label the angle of incidence with the letter *i*, [2]

(ii) show how these rays form the image of C and label the position of this image with the letter I. [2]

(b) Fig. 5.2 shows a thin converging lens focusing the image of a distant object (letter 'P') onto a screen.

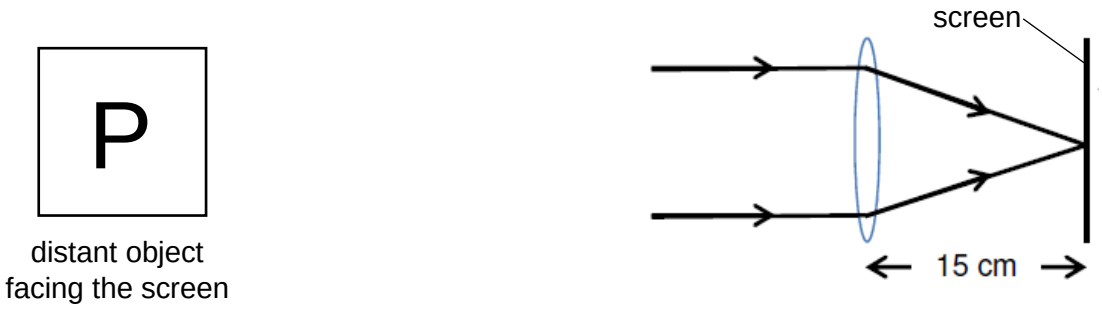


Fig. 5.2

A sharp image is formed when the distance between the lens and the screen is 15 cm.

(i) Fig. 5.3 shows the front of the screen. On Fig. 5.3, draw the image of the letter 'P' as seen on the screen. [1]

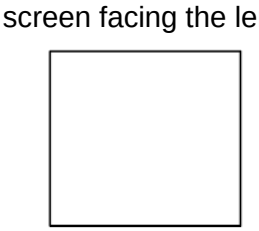


Fig. 5.3

(ii) The object (letter 'P') is now placed 20 cm from the lens as shown in Fig. 5.4.

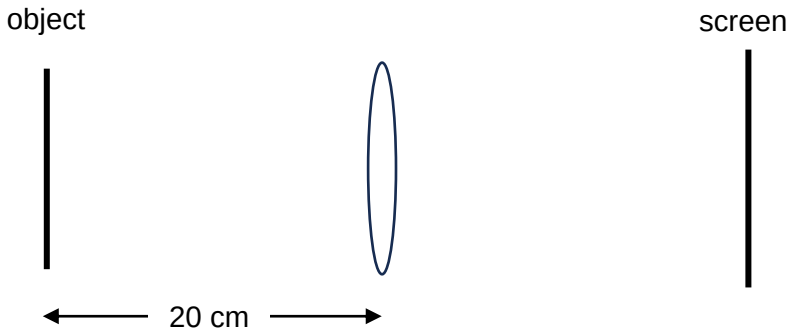


Fig. 5.4

The screen is then adjusted so that a sharp image is formed on the screen. State two differences between this image and the image in part **(i)**.

1. ……

2. ……

[2]

6(a) A helicopter gets negatively charged by friction when it flies through the air.

(i) Explain how this happens.

……

……

…….. [2]

(ii) Fig. 6.1 shows a soldier (soldier A) touching the base of the helicopter with a metal rod attached to a conducting wire that is touching the ground. He needs to do this before his fellow soldier (soldier B) hooks up the cargo to the helicopter.

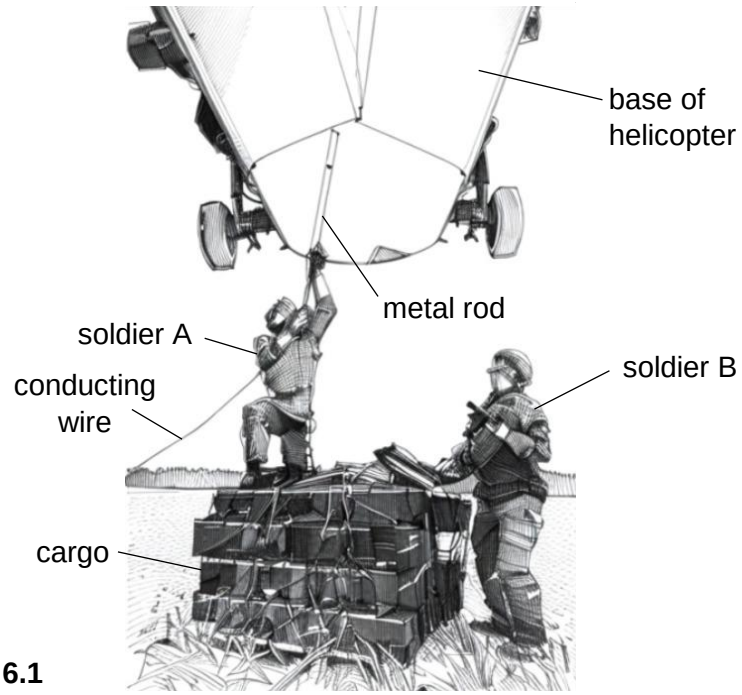


Fig. 6.1

Explain why soldier A's action will prevent soldier B from getting an electric shock while he is hooking up the cargo.

.....

.....

..... [2]

(b) Another hazard of static electricity is lightning. During the major part of a lightning strike, there is a current of 32 kA in a lightning rod for a time of 15 ms. Calculate the charge flowing through a point in the lightning rod during this time.

charge = ... [2]

7 Fig. 7.1 shows an electric circuit of a room in a house that has been correctly set up by a certified electrician. The position of the fuse is not shown.

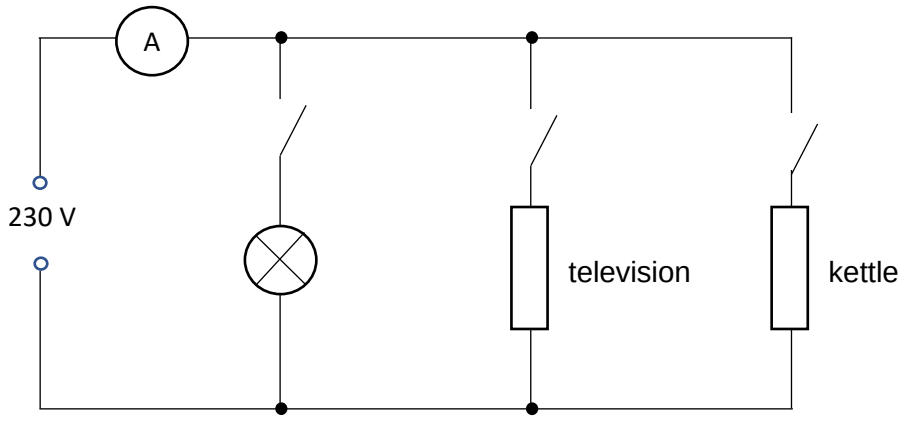


Fig. 7.1

A person switches on three pieces of electrical equipment in the following sequence:
1. lamp
2. television
3. kettle

An ammeter connected in the circuit shows that the current to the lamp alone is 0.50 A. When both the lamp and the television are on, the current is 1.70 A. When all three pieces of equipment are in use, the current is 8.70 A.

(a) State what is meant by a *current*.

…….. [1]

(b) On Fig. 7.1, draw a suitable position for the fuse and indicate a suitable value of the fuse. [2]

(c) Calculate the resistance of the kettle.

resistance = ……. [2]

(d) The cost of 1 kW h of energy is 28 cents. Calculate the cost of using all three pieces of equipment for 3 hours.

cost = ……. [2]

8(a) Fig. 8.1 and Fig. 8.2 show views of a wire carrying a current downwards through a horizontal board.

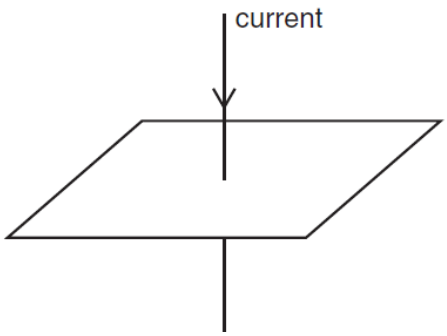


Fig. 8.1

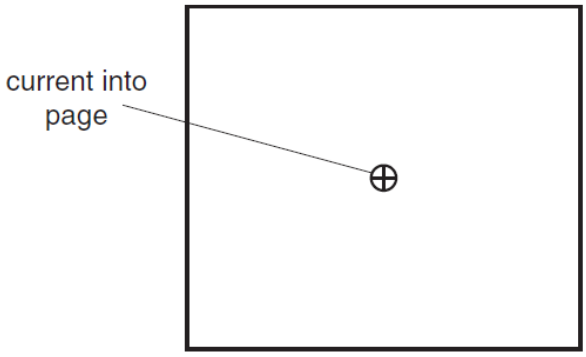


Fig. 8.2 (viewed from above)

On Fig. 8.2, draw the magnetic field due to the current in the wire. [2]

(b) Fig. 8.3 shows the circuit diagram of an electric bell.

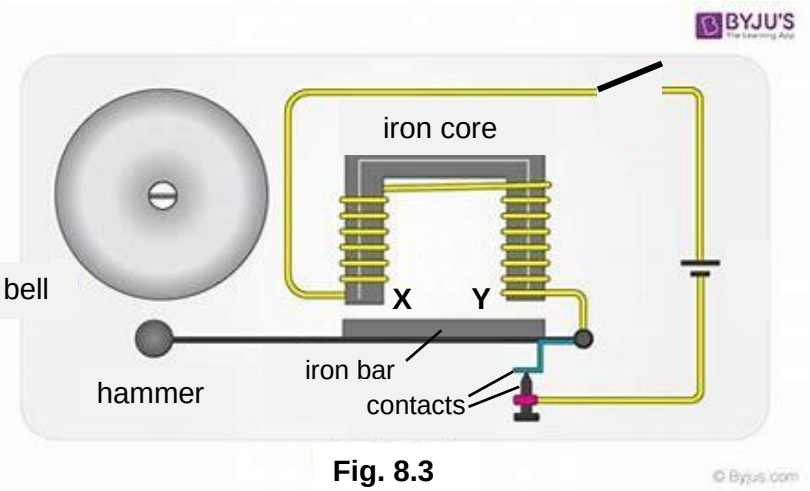


Fig. 8.3

The switch is closed and the iron core gets magnetised.

(i) State the poles produced at the ends **X** and **Y** of the iron core.

X = …… pole; **Y** = …… pole [1]

(ii) After the iron core gets magnetised, the iron bar gets attracted upwards to the iron core and the hammer strikes the bell. At the same time, the two contacts are separated and creates an open circuit. The iron core gets demagnetised and the iron bar falls back to its original place. The two contacts touch each other again and closes the circuit. The process repeats and the bell rings continuously until the switch is open.

Explain why the electric bell will not work well if the iron bar is replaced by a steel bar.

.....

.....

..... [2]

Section B

Answer **all** the questions in this section.

9 Cappuccino is an Italian, coffee-based drink prepared with expresso (a type of coffee), steam milk and milk foam. To make steam milk, hot steam is passed into the cold milk to heat up the milk. Fig. 9.1 shows machine passing hot steam into cold milk.

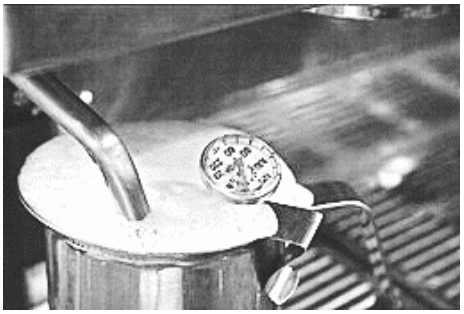


Fig. 9.1

Table 9.1 shows the specific heat capacities of some substances. Table 9.2 shows the heat constants of water.

Table 9.1

substance	specific heat capacity / J kg^{-1} $°C^{-1}$
glass	840
ice	2100
water	4200
steam	2010
milk	4000

Table 9.2

property	water
melting point / °C	0.0
specific latent heat of fusion / J kg^{-1}	3.34×10^5
boiling point / °C	100.0
specific latent heat of vaporisation / J kg^{-1}	2.26×10^6

(a) (i) Define *specific latent heat of vaporisation.*

…..……..

..……..... [2]

(iii) Suggest why the specific latent heat of vaporisation is much larger than the specific latent heat of fusion.

…..……..

…..……..

..……..... [1]

(b) 200 g of milk is poured into a 100 g glass container. Using the information in Table 9.1 and Table 9.2,

(i) show that 30.9 kJ of heat is required to warm 200 g of milk in a 100 g glass container from 15.0°C to 50.0 °C. [2]

(ii) calculate the minimum mass of steam, initially at 130.0°C that is needed to warm the milk and the glass in part **(i)**.

mass = ……. [2]

(c) A student suggested using a 15.0 kW lamp to heat the milk from above. However, he found that this process is only 5% efficient.
State the possible modes of heat transfer and suggest 2 reasons for the low efficiency.

……..……..

……..……..

……..……..

……..……..

……..……..... [3]

10 The last decade has seen an explosion in the use of hand phones. The hand phone works by transmitting and receiving ultra-high frequency radio waves to and from the nearest base station. To avoid interference, different frequencies are used for transmitting and receiving signals. Table 10.1 shows the frequency bands allocated for one base station:

Table 10.1

purpose	frequency band
transmitting signals to the base station	890 MHz to 915 MHz
receiving signals from the base station	935 MHz to 960 MHz

To transmit good quality signals, each complete signal is about 20 kHz wide. Within the band available for transmission or reception, individual signals are set 25 kHz apart to avoid overlap.

The hand phone uses low power transmitters of 1.5 W to 3.0 W. Small, efficient rechargeable batteries are needed to power the hand phones. Typically, a battery supplies 75 kJ of electrical energy before it needs to be recharged.

(a) State what is meant by *frequency*.

…..…… [1]

(b) State one difference between radio waves and sound waves.

……..……..…….

……..……..…… [1]

(c) (i) State the speed of radio waves in air.

…..…….…… [1]

(ii) Calculate the maximum wavelength that a hand phone uses to transmit a signal to the nearest base station.

wavelength = ……. [2]

(d) Calculate the number of individual hand phones that one base station can support.

number = …… [1]

(e) Estimate the maximum time that a battery will last if the hand phone is used for continuous transmission.

time = …… [1]

(f) A sound wave from a hand phone is illustrated in Fig. 10.1.

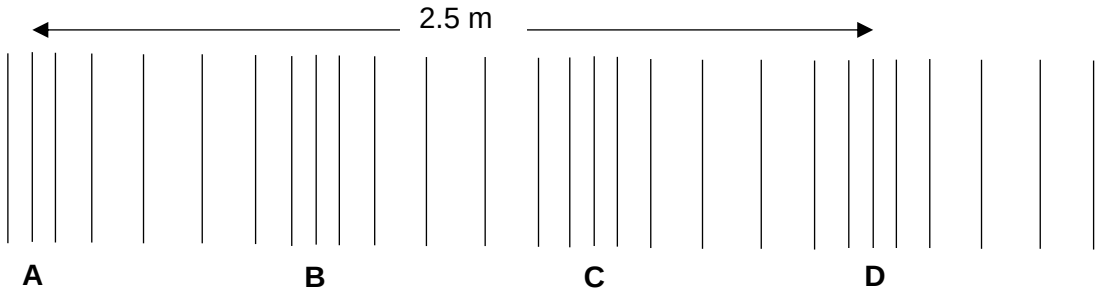


Fig. 10.1

Points **A, B, C**, and **D** are the centres of regions of a compression.
Points **A** and **D** are 2.5 m apart.

(i) Calculate the wavelength of the sound wave.

wavelength = …… [1]

(ii) The sound wave in Fig. 10.1 travels from air to water. Explain why the distance between A and D increases as the sound wave travels from air to water.

……

……

……

…… [2]

11 EITHER

Fig. 11.1 shows a thin sheet of metal with two holes punched at A and C. It is then suspended from the hole at A. The weight of the metal is 0.20 N and the centre of gravity is at B. The diagram is drawn to scale.

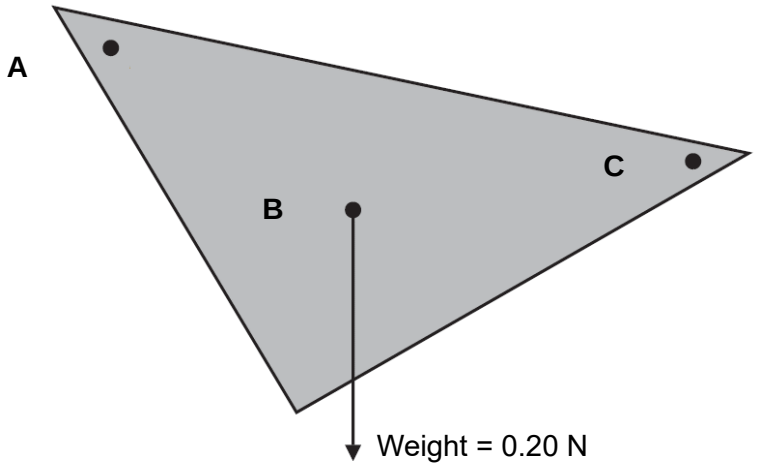


Fig. 11.1 (drawn to scale)

(a) The sheet in Fig. 11.1 turns because of the moment of the weight about point A.

(i) State what is meant by *moment of a force*.

……

…… [1]

(ii) Using Fig. 11.1, determine the moment of the weight about point A.

moment = ... [2]

(b) Describe in detail how you would experimentally determine the position of the centre of gravity of the sheet of metal.

……

……

……

……

……

…… [3]

(c) A student uses identical thick blocks of wood to explore moments and stability. Fig. 11.2 to Fig. 11.4 show the front view of a block of wood held in different positions on a table.

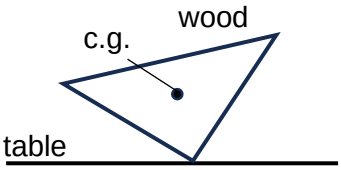


Fig. 11.2

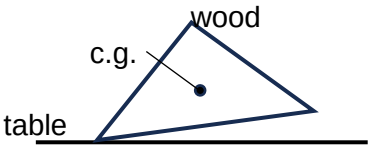


Fig. 11.3

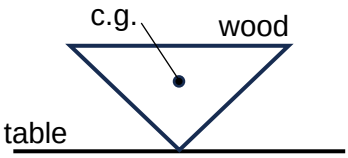


Fig. 11.4

(i) State and explain which block of wood does not fall to the left or to the right when released.

……

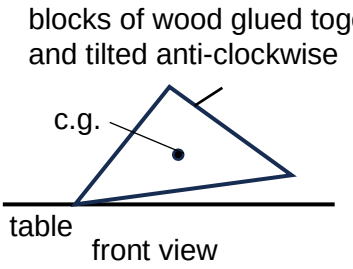
……

……

…… [3]

(ii) The student then glued some blocks of wood together. He tilted the final product by the same angle as the wood in Fig. 11.3.

Fig. 11.5 shows the front view and the top view of these blocks of wood.



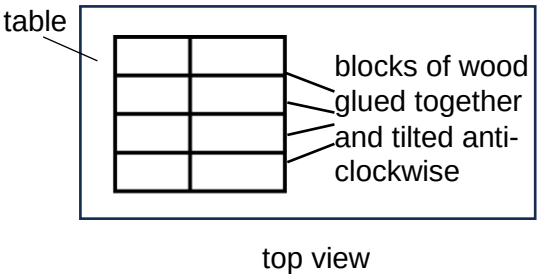


Fig. 11.5

Explain whether the student finds these blocks of wood that are glued together to be more stable than or as stable as the single block of wood in Fig. 11.3 when tilted as shown in Fig. 11.5.

.....

.....

…… [1]

11 OR

In the early days, New York City had a 120 V direct current electricity supply. Electric power was supplied to a house using two copper cables as shown in Fig. 11.6.

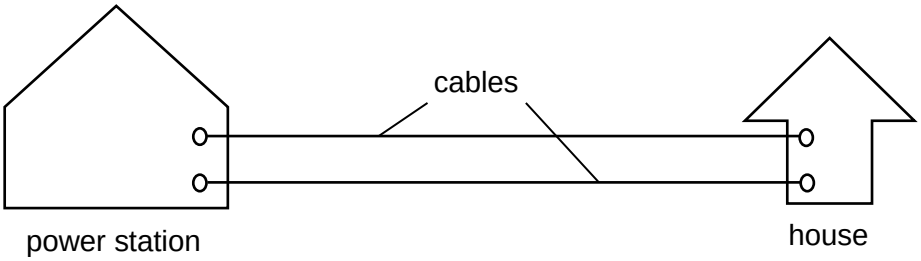


Fig. 11.6

The resistance of each copper cable is 0.30 Ω. The demand for electric power was small at that time. For a power of 18 kW supplied from the power station, the current flowing in the cables is 150 A.

(a) Calculate the power wasted heating the cables,

power wasted = …….. [2]

(b) The system was very inefficient due to the power loss through the cables.

(i) Explain why efficiency decreases as more houses in the city requires electricity.

……

……

……

……

…….. [2]

(ii) Explain why increasing the output voltage of the power station would have improved the efficiency.

……

……

……

……

…….. [2]

(iii) Another way of increasing the efficiency of the system is to reduce the resistance of the transmission wires. Explain why this method is not adopted by electrical companies.

……

……

……

…….. [2]

(c) Transformers are used to step up voltages to improve the efficiency of power transmission. Explain why there must be an alternating current in the primary coil for the transformer to work.

……

……

……

…….. [2]

Acknowledgement:

Fig. 6.1: https://aviation.stackexchange.com
Fig. 9.1: Tijuana Brass at en.wikipedia, CC BY-SA 3.0 <http://creativecommons.org/licenses/by-sa/3.0/>, via Wikimedia Commons