

FOR OFFICIAL USE

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3220/401

K & U	PS

Total Marks

NATIONAL
QUALIFICATIONS
2005

TUESDAY, 24 MAY
9.00 AM - 10.30 AM

PHYSICS
STANDARD GRADE
General Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

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Scottish candidate number

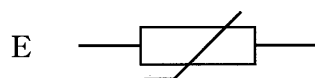
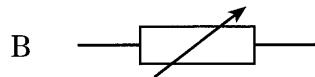
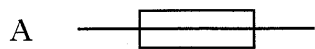
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Number of seat

- All questions should be answered.
- The questions may be answered in any order but all answers must be written clearly and legibly in this book.
- For questions 1–6, write down, in the space provided, the letter corresponding to the answer you think is correct. There is only **one** correct answer.
- For questions 7–21, write your answer where indicated by the question or in the space provided after the question.
- If you change your mind about your answer you may score it out and replace it in the space provided at the end of the answer book.
- Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.



1. Which of the following is the circuit symbol for a fuse?



Answer

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1

2. What is the main energy transformation that takes place in a thermocouple?

- A Heat to light
 B Electrical to heat
 C Heat to electrical
 D Light to heat
 E Heat to chemical

Answer

1

3. A 20 newton weight is hung on a spring balance. The spring extends by 0.10 metre. The weight is removed and a bag of potatoes is hung on the balance. The spring extends by 0.15 metre.

What is the weight of the bag of potatoes?

- A 10 newtons
 B 15 newtons
 C 20 newtons
 D 30 newtons
 E 50 newtons

Answer

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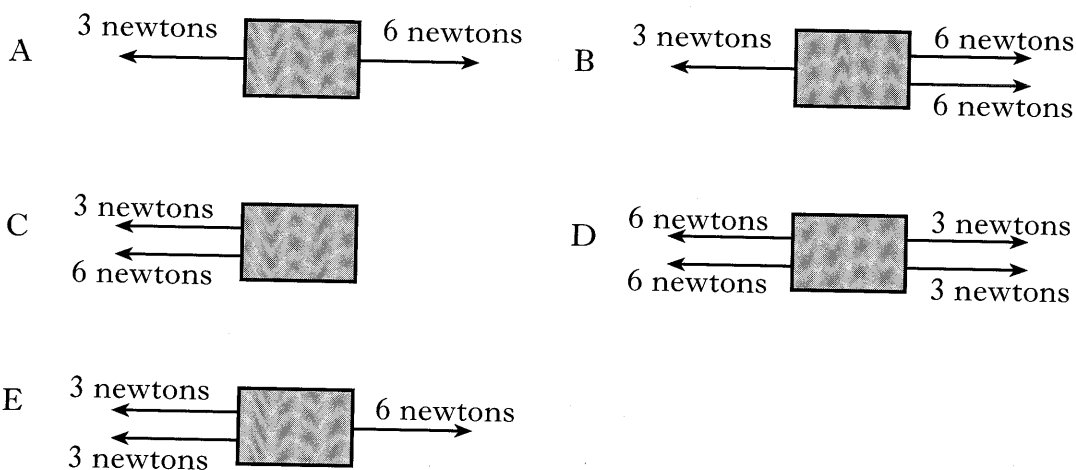
4. A car designer wants to increase the maximum acceleration of a car. Which entry shows what should be done to the engine force and the mass of the car?

	<i>Engine force</i>	<i>Mass</i>
A	keep the same	increase
B	increase	decrease
C	increase	keep the same
D	decrease	increase
E	decrease	keep the same

Answer

1

5. The diagrams below show the forces acting on a number of moving objects. Which object is moving at constant speed?



Answer

1

6. Which row gives the correct units for work done, energy and power?

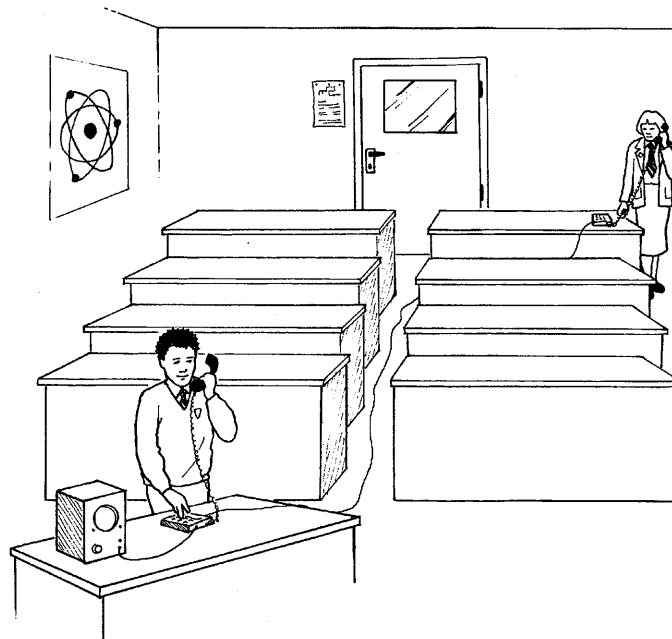
	<i>Work done</i>	<i>Energy</i>	<i>Power</i>
A	newton	joule	watt
B	joule	joule	watt
C	newton	watt	joule
D	watt	newton	watt
E	joule	watt	newton

Answer

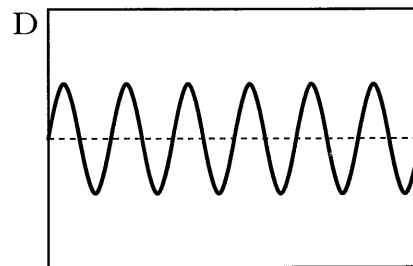
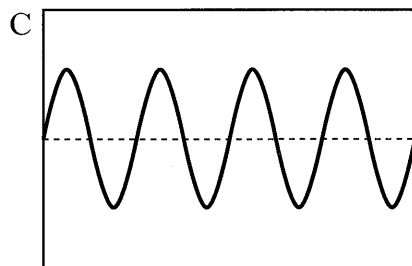
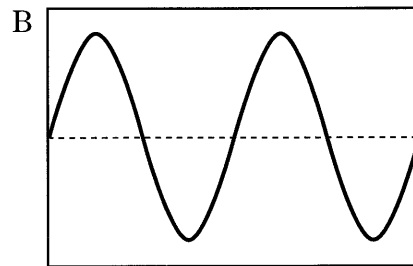
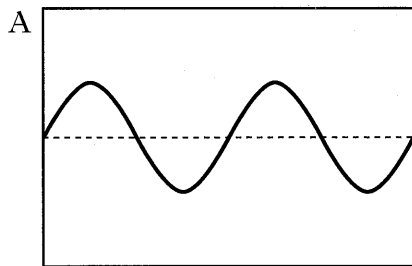
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7. Two students are investigating a telephone system in a laboratory.



(a) An oscilloscope is connected to the microphone in one of the telephones. One student whistles several times into this microphone and the electrical signals shown are obtained.



All the traces shown are obtained without changing the controls on the oscilloscope.

Which of these electrical signals is caused by

(i) the highest frequency sound

Answer

(ii) the loudest sound?

Answer

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7. (continued)

(b) In the telephone system, electrical signals carry the information from the transmitter to the receiver.

One student makes a loud sound. The other student hears this sound through the telephone and also directly through the air.

Explain which sound reaches the student first.

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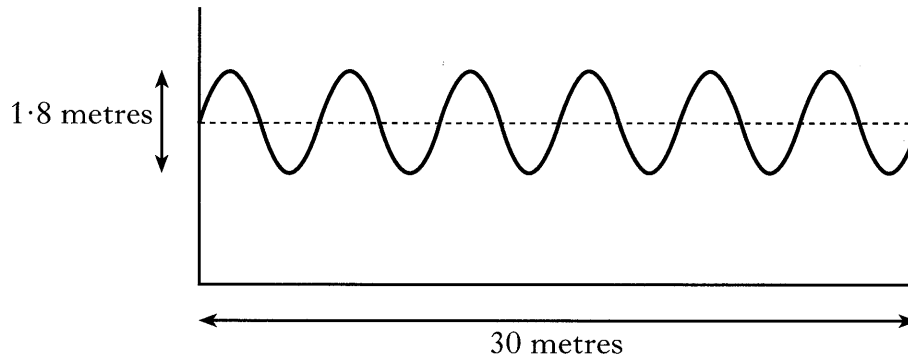
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8. In a research laboratory, water waves are generated in a tank. During one test the wave shown travels along the tank at 2.5 metres per second.



- (a) Calculate the amplitude of the wave shown.

Space for working and answer

1

- (b) Calculate the wavelength of the wave shown.

Space for working and answer

2

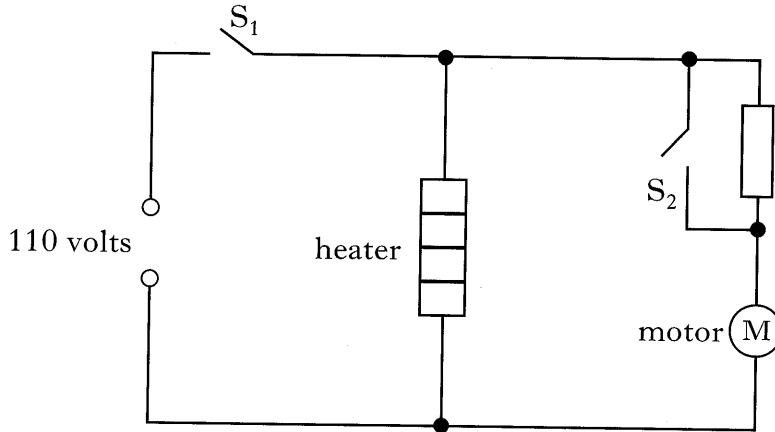
- (c) Calculate the frequency of the wave shown.

Space for working and answer

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9. A two-speed hot air blower is used in a factory. The blower operates from a 110 volt supply. The blower contains a heater, and a fan attached to a motor. The blower is switched on by closing switch S_1 .



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- (a) What is the voltage across the heater when the blower is operating?

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- (b) Explain why switch S_2 should now be closed for the blower to operate at high speed.

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- (c) When operated at high speed, the blower is rated at 2000 watts. The blower is operated at high speed for 8 hours.

- (i) Calculate the number of kilowatt-hours of energy it uses in this time.

Space for working and answer

2

- (ii) Electricity costs 9 pence per kilowatt-hour. Calculate the cost of operating the blower for 8 hours.

Space for working and answer

2

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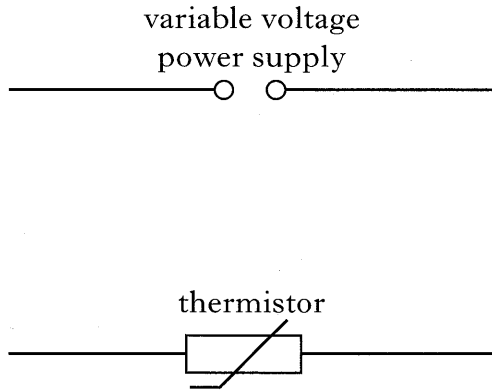
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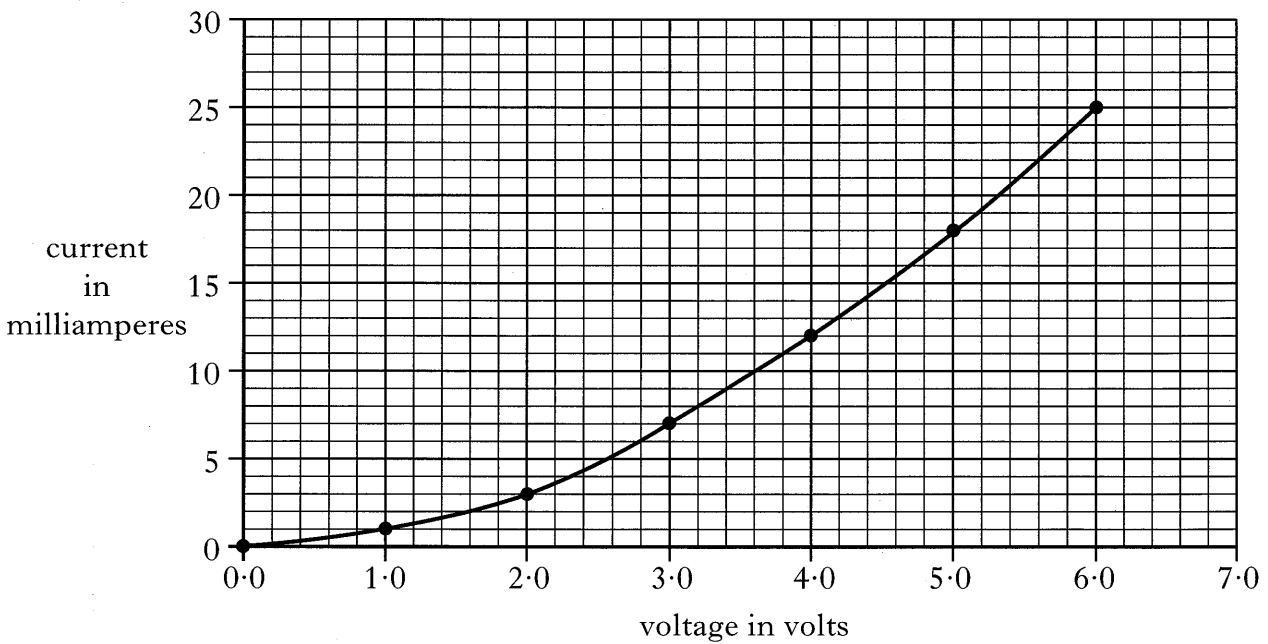
10. A variable power supply, an ammeter and a voltmeter are used to investigate how the current in a thermistor changes as the voltage across the thermistor changes.

(a) Complete the circuit diagram, including the ammeter and voltmeter, to show how the current and voltage measurements are obtained.



3

(b) The current and voltage measurements obtained are used to draw the graph shown.



(i) What is the current in the thermistor when the voltage across the thermistor is 5.0 volts?

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10. (b) (continued)

- (ii) Calculate the resistance of the thermistor when the voltage across the thermistor is 5.0 volts.

<i>Space for working and answer</i>

- (iii) How does the resistance of the thermistor change as the voltage across the thermistor increases?

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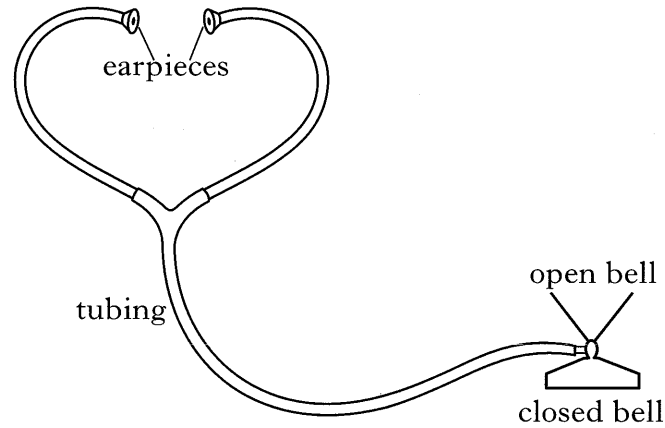
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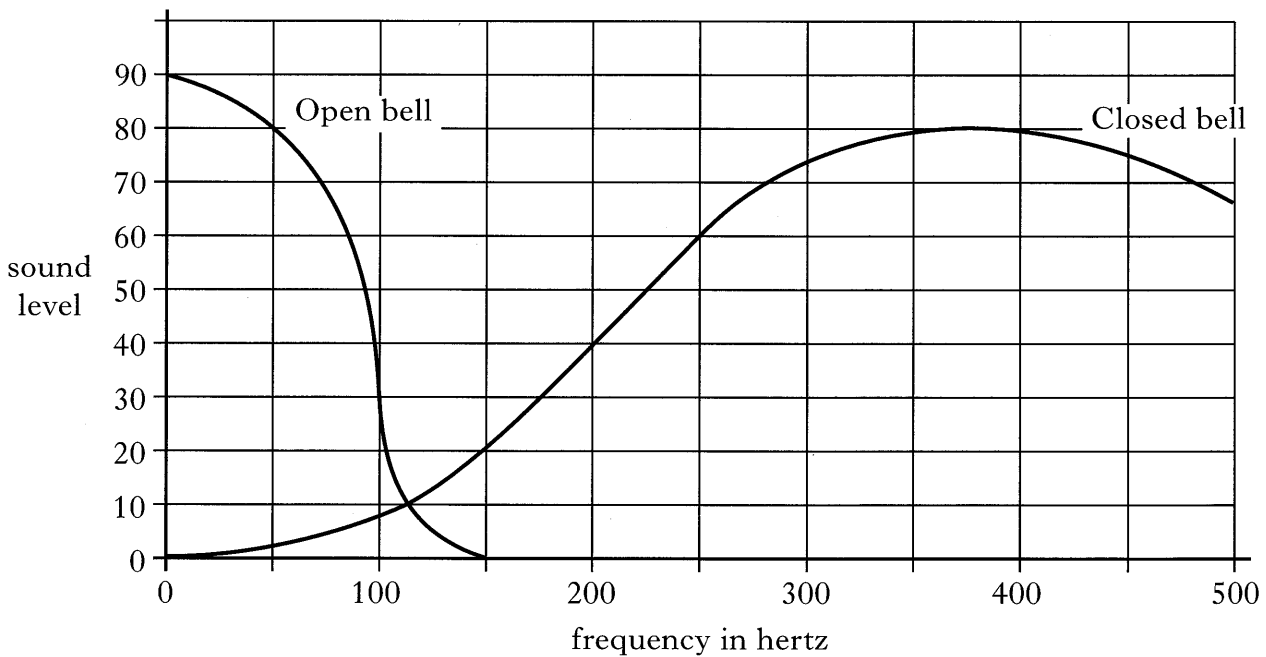
11. A stethoscope is used to listen to sounds made inside a body. The diagram below shows the main parts of a stethoscope.



The open or closed bell is placed on the body to detect sounds.

The open bell is used for listening to heart sounds.

The graph shows how the sound level varies with the frequency of the sound detected by the bell.



- (a) The unit used to measure sound level has been omitted from the graph.
What is the unit of sound level?

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11. (continued)

(b) **Using information given**, explain whether heart sounds are high or low frequency sounds.

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(c) Why is it important that the earpieces of the stethoscope fit tightly in the ears?

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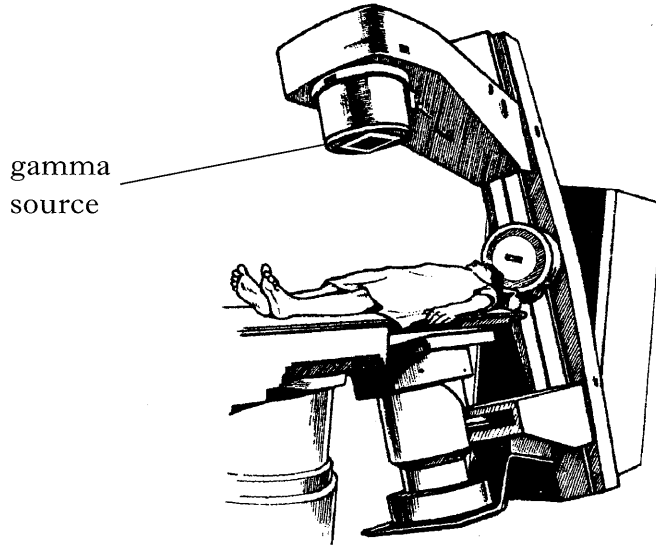
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12. The diagram shows a machine that emits nuclear radiation to treat bone cancer.



(a) Cancer cells are living cells that grow abnormally.

(i) What is the effect of nuclear radiation on cancer cells?

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(ii) The machine emits gamma radiation.

Explain why gamma radiation is used rather than alpha or beta radiation.

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1

(iii) Explain why the gamma radiation source is rotated around the patient.

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12. (continued)

- (b) The nurse who operates the machine wears a film badge containing a small piece of photographic film.



What effect does nuclear radiation have on photographic film?

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13. The table below lists the upper and lower frequency limits that apply to the hearing range of different animals.

<i>Animal</i>	<i>Frequency of lower limit of hearing (hertz)</i>	<i>Frequency of upper limit of hearing (hertz)</i>
bat	16 000	120 000
mouse	500	60 000
cat	500	30 000
human	20	20 000

- (a) What is the highest frequency that can be heard by a mouse?

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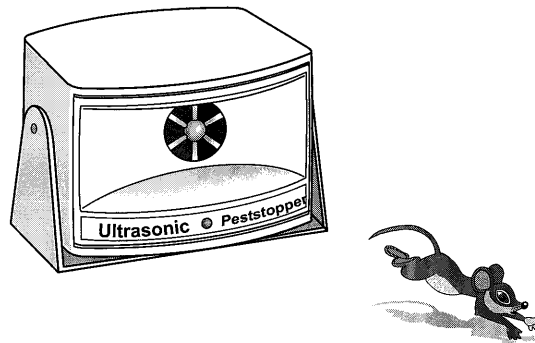
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- (b) Which animal **mentioned in the table** can hear the greatest range of frequencies?

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- (c) Animals are annoyed by loud sounds within their hearing range. A householder wants to get rid of mice using an ultrasound emitter.



- (i) What is meant by ultrasound?

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- (ii) The householder does not want to annoy cats.
Suggest a frequency that the ultrasound emitter could operate at.

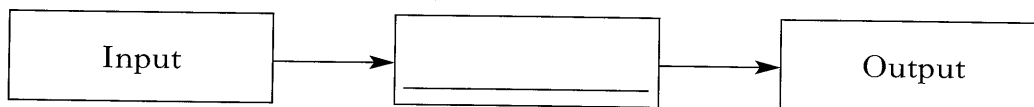
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14. A hearing aid is an electronic system.

- (a) An electronic system can be represented by a block diagram as shown.
Complete the block diagram by filling in the missing label.



- (b) The hearing aid contains an input device, an amplifier and an output device.

(i) Select a suitable device **from the list below** to be used as the input.

- light dependent resistor** **switch** **microphone**
thermocouple **solar cell** **thermistor**

.....

- (ii) The output device transforms electrical energy into sound energy.
State a suitable device to be used as the output.

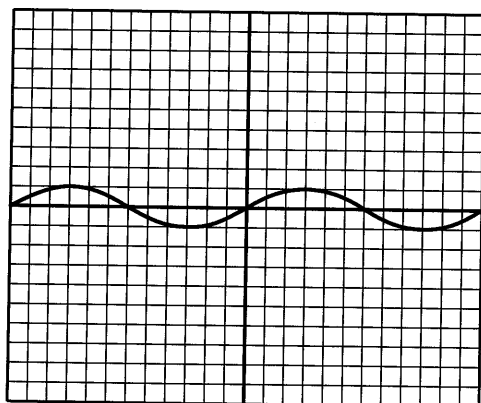
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- (c) During a test of the hearing aid, the voltage generated by the input device is 0.15 volt. The voltage across the output device is 0.45 volt.
Calculate the voltage gain of the amplifier.

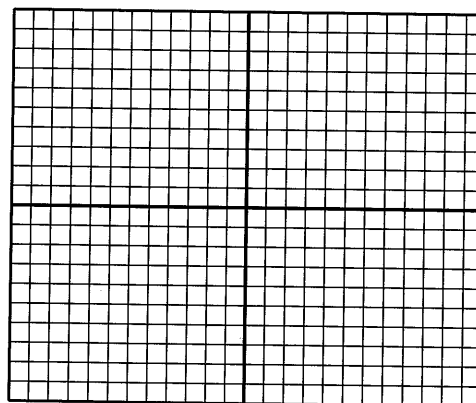
Space for working and answer

- (d) The voltage gain of the amplifier is now set at 5. The input signal to the amplifier is shown below.

Draw the output signal from the amplifier using the same scales.



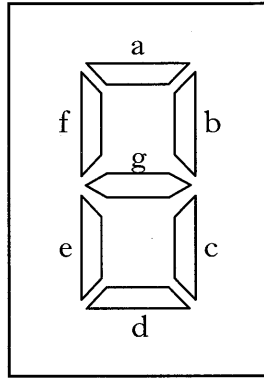
Input signal to amplifier



Output signal from amplifier

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15. A seven-segment display contains seven light emitting diodes (LEDs) arranged as shown in the diagram. Numbers are displayed by switching segments on or off.



Seven-segment display

- (a) What number is shown on the seven-segment display when only segments a, c, d, f and g are switched on?

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1

- (b) Draw the circuit symbol for an LED.

Space for circuit symbol

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- (c) In use, each LED is connected in series with a resistor. State the function of this resistor.

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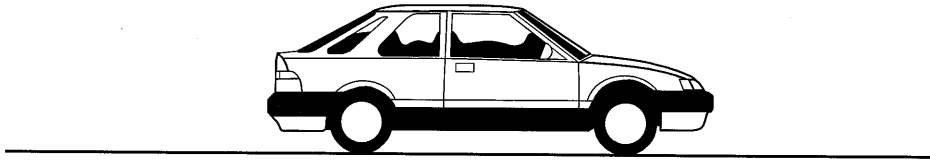
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16. A car travels forwards along a level road at a constant speed.

- (a) Label the diagram to show the horizontal forces acting on the car.
You must indicate the direction of each force.



(b) The car brakes suddenly.

- (i) Explain, in terms of forces, why it is important for the passengers to be wearing seat belts.

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- (ii) A force of 8000 newtons stops the car when the brakes are applied. The mass of the car is 1000 kilograms. The car stops in a distance of 23 metres.

(A) Calculate the acceleration of the car as it comes to rest.

Space for working and answer

(B) How much work is done stopping the car?

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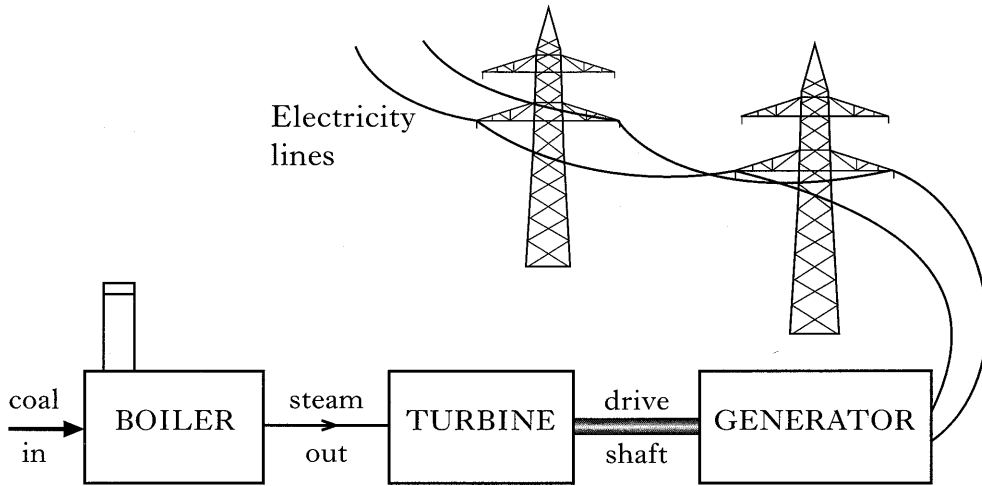
- (iii) What is the main energy transformation in the car brakes?

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17. Electricity can be generated from different energy sources.
(a) Coal is a fossil fuel that is used to generate electricity.



- (i) In a coal-fired power station, identify the energy transformation in the boiler, the turbine and the generator.

boiler: to

turbine: to

generator: to

3

- (ii) State **one** disadvantage of using fossil fuels to generate electricity.

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- (b) Electricity can also be generated in nuclear power stations.

State **one** disadvantage of using nuclear fuel.

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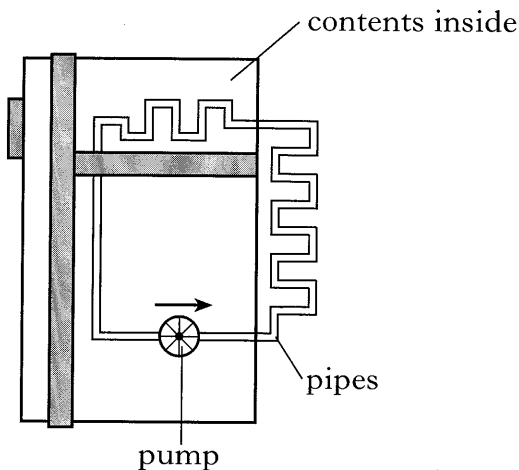
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18. The contents of a refrigerator are kept cool by removing heat.

This happens because a chemical called a coolant evaporates as it is pumped round pipes in the refrigerator.



(a) (i) Which of the following changes of state of the coolant is used to remove heat from the contents?

- A Gas to liquid
- B Liquid to solid
- C Liquid to gas

Answer

1

(ii) Explain why this change of state removes heat from the contents of the refrigerator.

.....

1

(b) A bottle containing 0.75 kilogram of milk at 22 degrees celsius is cooled in the refrigerator to 5 degrees celsius.

Calculate how much energy is removed from the milk.

[The specific heat capacity of milk is 4000 joules per kilogram per degree celsius.]

Space for working and answer

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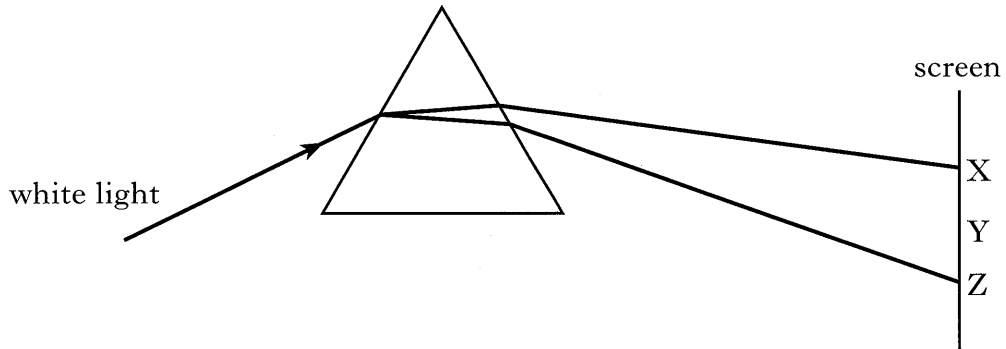
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19. White light is part of the electromagnetic spectrum—a family of waves with different wavelengths.

(a) What property do all these waves have in common?

1

(b) White light can be split into different colours.



(i) What is the name of the glass block that is used to split light into different colours?

1

(ii) The colours appear on the screen in order of wavelength. The colour with the longest wavelength appears at X.

Which of the colours blue, green and red is seen on the screen at each position X, Y and Z?

X.....

Y.....

Z.....

2

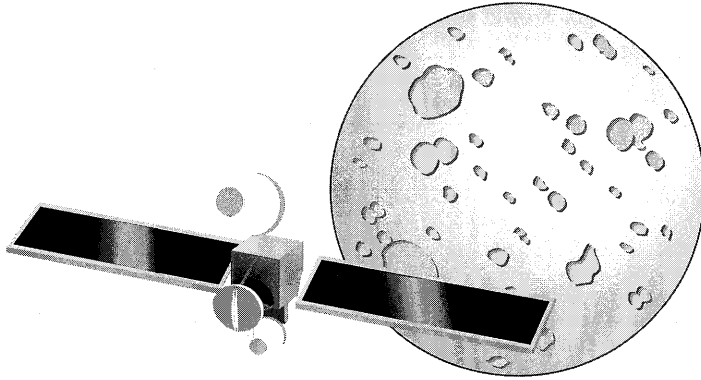
(iii) Which of the colours blue, green and red has the highest frequency?

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21. A spacecraft is fitted with a motor that uses electrical energy generated from sunlight. The motor is designed to propel the spacecraft from the Earth to the Moon. The mass of the spacecraft is 420 kilograms.



- (a) Name a suitable device that can be used to transform light into electrical energy.
-

1

- (b) The spacecraft has an acceleration of 0.2 millimetre per second per second when the motor is first switched on.
Calculate the thrust acting on the spacecraft.

<i>Space for working and answer</i>

2

- (c) The motor provides thrust for the spacecraft by expelling gas at very high speed. Explain why the spacecraft moves forward when the gas is expelled.
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