SCOTTISH QUALIFICATIONS AUTHORITY

2005 Physics

Standard Grade General

Finalised Marking Instructions

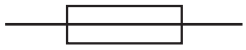
These Marking Instructions have been prepared by Examination Teams for use by SQA Appointed Markers when marking External Course Assessments.

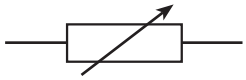
DO NOT WRITE IN THIS MARGIN

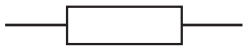
	K&U	PS

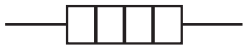
Marks

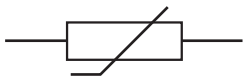
1. Which of the following is the circuit symbol for a fuse?

A 

B 

C 

D 

E 

Answer **A** **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 **C** **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 **D** **1**

NOTES

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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?

	Engine force	*Mass*
A	keep the same	increase
B	increase	decrease
C	increase	keep the same
D	decrease	increase
E	decrease	keep the same

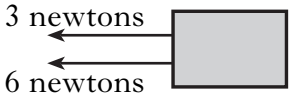
Answer **B** **1**

5. The diagrams below show the forces acting on a number of moving objects.

Which object is moving at constant speed?

A 

B 

C 

D 

E 

Answer **E** **1**

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

	Work done	*Energy*	*Power*
A	newton	joule	watt
B	joule	joule	watt
C	newton	watt	joule
D	watt	newton	watt
E	joule	watt	newton

Answer **B** **1**

NOTES

DO NOT WRITE IN THIS MARGIN

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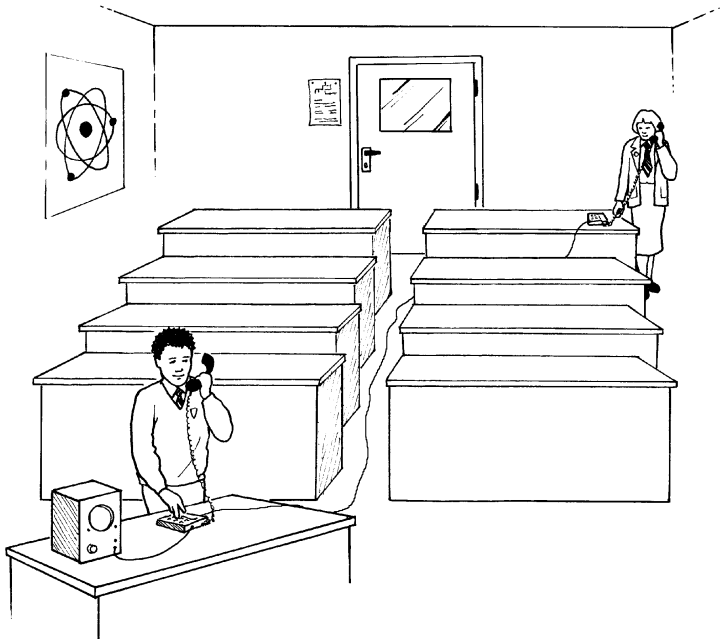
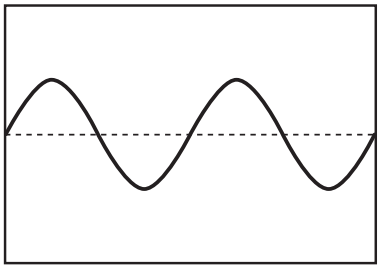
Marks

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

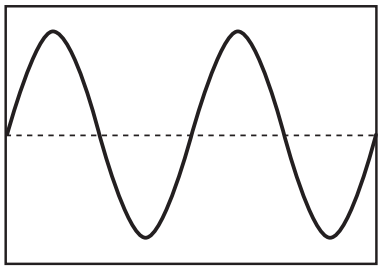


(*a*) An oscilloscope is connected to the microphone in one of the telephones. One student whistles several times into this microphone and the electrical signals shown are obtained.

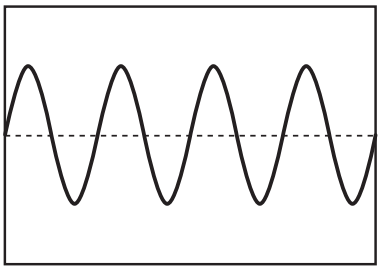
A



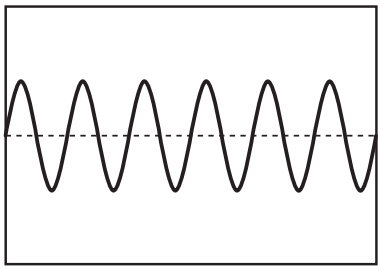
B



C



D



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* **D**

(ii) the loudest sound? *Answer* **B** **2**

NOTES

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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.

(Sound via) telephone (system) (1)

(Electrical) signals travel faster in wires/sound travels slower in air (1)

..... **2**

NOTES

Independent marks

Accept value: **sound 340 m/s**
electrical signals ≈ 3×10^8 m/s

If only "signals travel faster in wires" → (1) mark

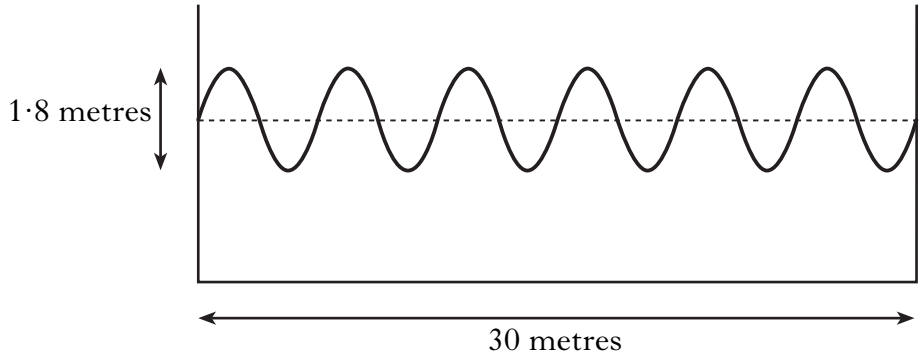
Light/optical fibre answer → (0) mark
(does not answer question)

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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

amplitude = $\frac{1{\cdot}8}{2}$

= 0·9 m (–½) if no unit

1

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

Space for working and answer

wavelength = $\frac{\text{length of tank}}{\text{number of waves}}$ (½)

= $\frac{30}{6}$ (½)

= 5 m (1)

2

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

Space for working and answer

$v = f\lambda$ ½ $\therefore$ $f = \frac{v}{\lambda}$

= $\frac{2{\cdot}5}{5}$ (½)

= 0·5 Hz (1)

2

NOTES

OR: $\mathbf{t = \frac{d}{v} = \frac{30}{2{\cdot}5} = 12}$

$\therefore$ 6 waves (counted) in 12 s

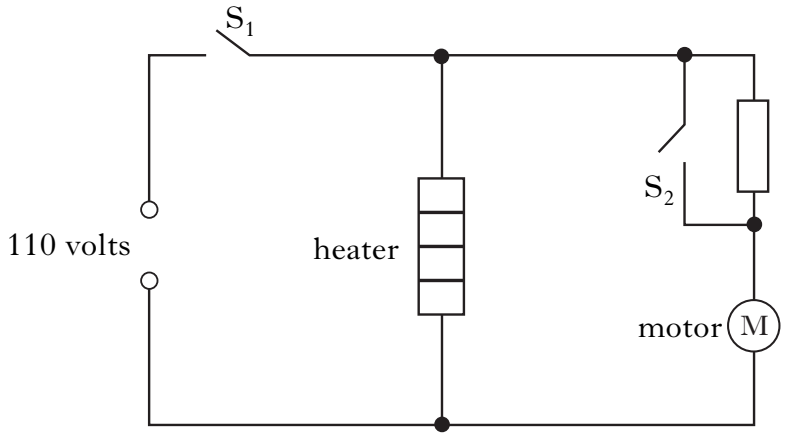
$\therefore$ f = 0·5 Hz

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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.



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

110 V (1 or 0) **1**

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

S_2 short circuits the resistor OR less resistance (1)

more current OR more voltage OR more power (1) **2**

(*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

E = Pt (½) **2000W = 2kW**
= 2 × 8 (½) **(½)**
= 16 (kWh) (½)

2

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

Space for working and answer

Cost = energy × cost per unit (½)
= 16 × 9 (½)
= £1·44 (1)

2

NOTES

2 independent marks

<u>Not</u> more energy

If calculate energy in joules → (–½) mark (unit error)

Accept 144p { **in joules: 5·184 × 10^8p** }

Question No. 9

DO NOT WRITE IN THIS MARGIN

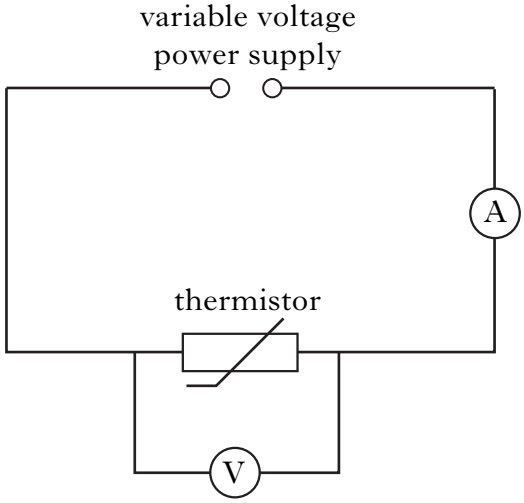
K&U	PS

Marks

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.

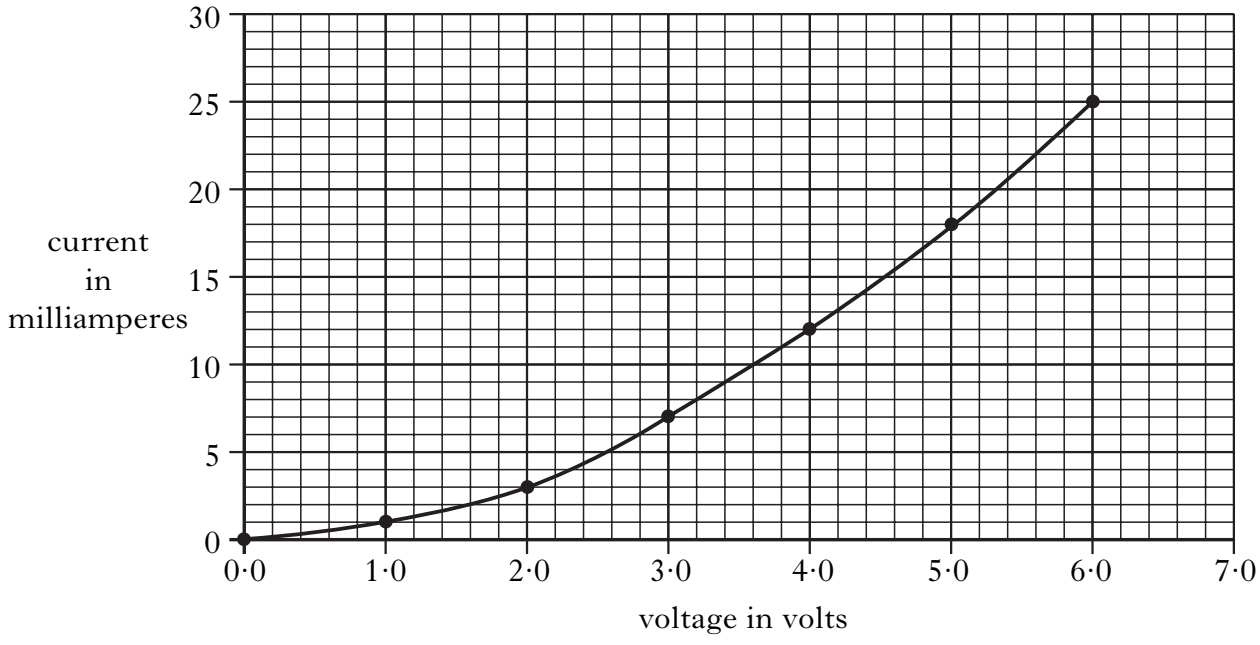
(*a*) Complete the circuit diagram, including the ammeter and voltmeter, to show how the current and voltage measurements are obtained.

ammeter symbol (½)
voltmeter symbol (½)
ammeter in series (1)
voltmeter across thermistor or power supply (1)



3

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



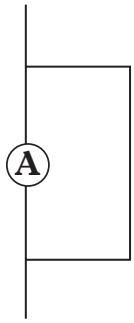
(i) What is the current in the thermistor when the voltage across the thermistor is 5·0 volts?

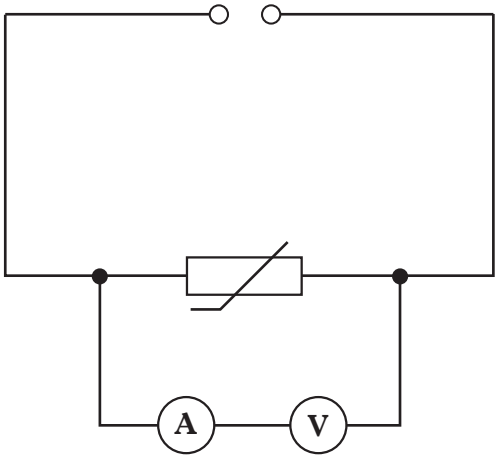
18 mA (1 or 0)

..... **1**

NOTES

(–1) if circuit will not work — ie

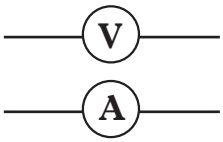




⇒ 2

Accept

only



⇒ 2 × (½) mark

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

10. (*b*) (continued)

(ii) Calculate the resistance of the thermistor when the voltage across the thermistor is 5·0 volts.

Space for working and answer

$\mathbf{V = IR}$ **(½)** $\mathbf{R = \frac{V}{I}}$

$= \frac{5}{18 \times 10^{-3}}$ **(½)**

$= 278\,\Omega$ **(1)**

2

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

decreases

1

NOTES

$277{\cdot}7\dot{7}$ on calculator — (–½) mark

300, 280, 278, 277·8

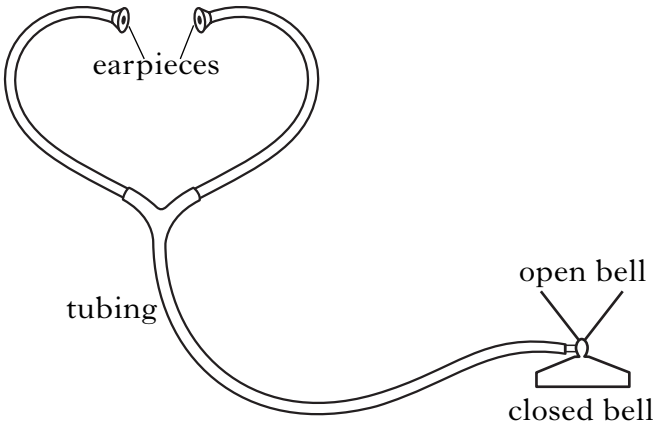
If no 10^{-3} ⇒ (1½) marks
(unless carried forward)

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

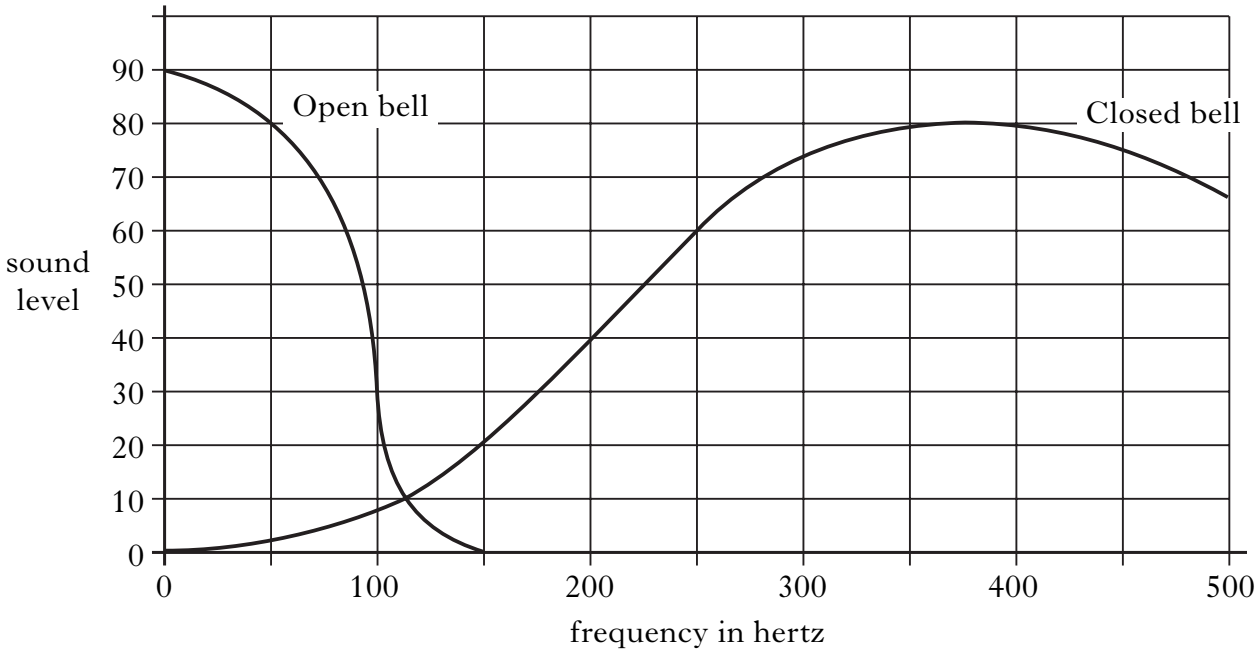
11. A stethoscope is used to listen to sounds made inside a body. The diagram below shows the main parts of a stethoscope.



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?

decibel OR dB **1**

NOTES
Accept wrong capitalisation **Ignore poor spelling**

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

11. (continued)

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

open bell for low frequencies OR frequencies below 150 Hz (½)

so heart sounds are low frequencies (½)

..... **1**

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

listener detects maximum sound input/blocks out unwanted sounds

..... **1**

NOTES

Independent marking

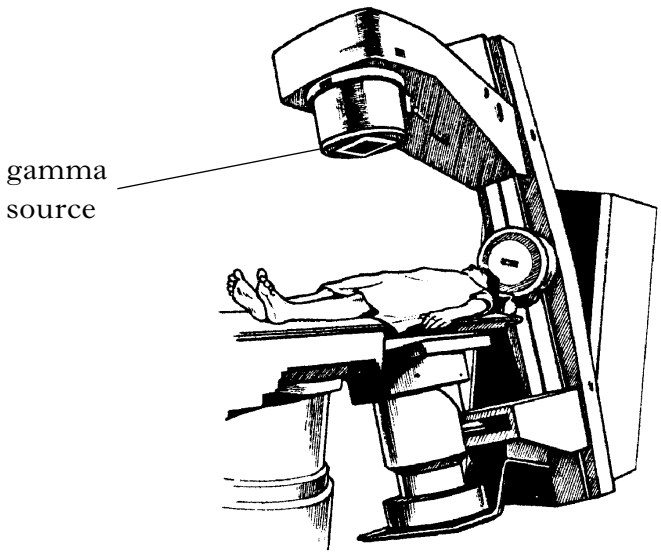
Accept any correct explanation involving numbers from the graph (does not need mention of open bell)

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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?

kills/destroys (cancer cells) **1**

(ii) The machine emits gamma radiation.

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

(gamma) penetrates body tissue **1**

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

maximum dose delivered

OR minimum dose to healthy tissue/focuses on cancer/

healthy tissue is not damaged **1**

NOTES

NOT makes cells weaker

accept correct mention of tissue type

if answer involves alpha/beta not able to penetrate — must mention both

range in air is ok for alpha NOT for beta

NOT "stronger"

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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?

darkens/blackens/clouds/fogs

..... **1**

NOTES
NOT discolours it **NOT changes it to a colour**

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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

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

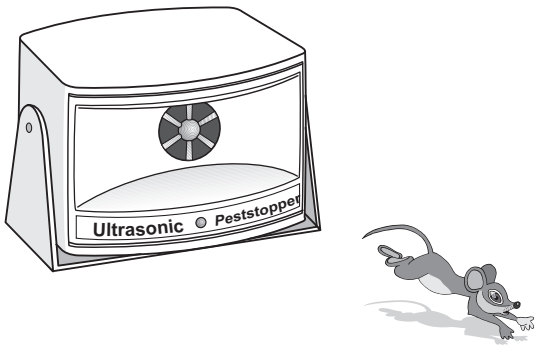
(*a*) What is the highest frequency that can be heard by a mouse?

60 000 Hz (1 or 0) **1**

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

bat **1**

(*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?

sound { beyond / above } range of human hearing/

sound of frequency greater than 20 000 Hz **1**

(ii) The householder does not want to annoy cats.

Suggest a frequency that the ultrasound emitter could operate at.

any stated frequency greater than 30 000 Hz and less than or equal to 60 000 Hz **1**

NOTES

NOT "sound too high" (must refer to frequency)

<u>Human</u> hearing, or value 20 0000 Hz is necessary

1 or 0

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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.

1

(*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**

microphone **1**

(ii) The output device transforms electrical energy into sound energy.

State a suitable device to be used as the output.

(loud)speaker **1**

(*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

Voltage gain $= \frac{V_o}{V_i}$ **(½)**

$= \frac{0{\cdot}45}{0{\cdot}15}$ **(½)**

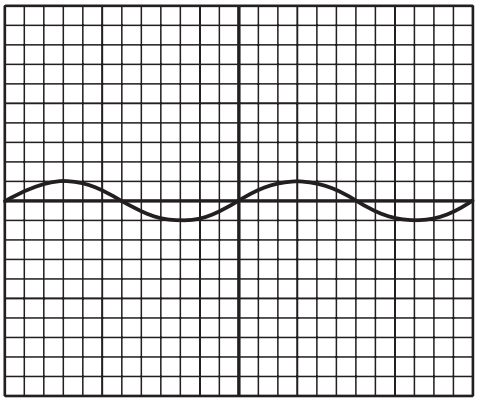
= 3 (1)

(deduct (½) if unit is given)

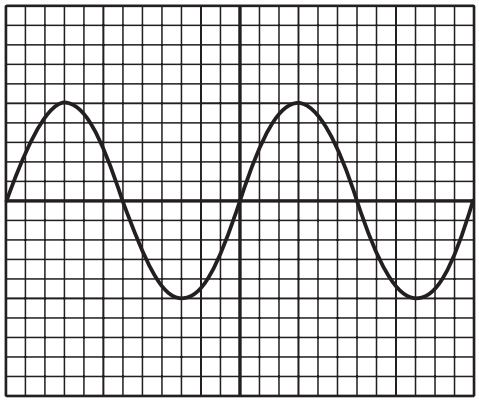
2

(*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

amplitude of 5 (½)

2 complete waves (½)

1

NOTES

ignore phase shift

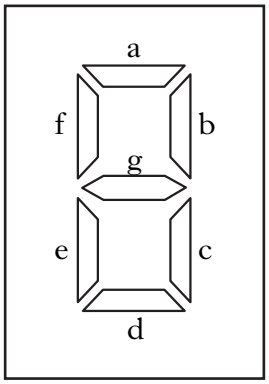
ignore y-shift

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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.



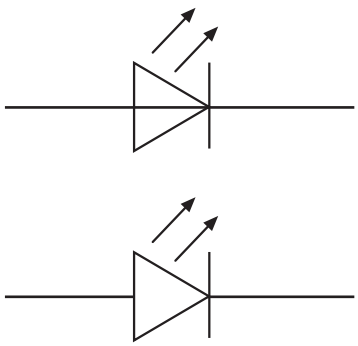
Seven-segment display

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

5 ..... **1**

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

Space for circuit symbol



or

1

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

current limiting resistor/prevents LED being .....

damaged (by large current)/protects the LED **1**

NOTES

Can also be answered by colouring in on diagram.

bar essential

arrows essential

leads essential

accept "limits voltage <u>across LED</u>"

(second part essential for voltage answer)

NOT power/power surge/blowing

DO NOT WRITE IN THIS MARGIN

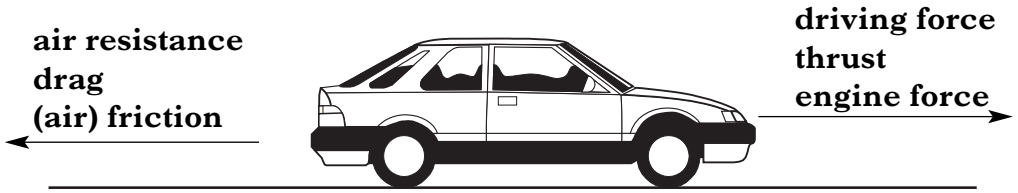
K&U	PS

Marks

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.



2

(*b*) The car brakes suddenly.

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

passengers must slow down at the same rate as the car (1)

seat belts exert a force on the passengers to

decelerate them (1) 2

(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

$a = \frac{F}{m}$ (½)

$= \frac{(-)\,8000}{1000}$ (½)

$= (-)8\ m/s^2$ (1)

2

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

Space for working and answer

work done = force × distance (½)

= 8000 × 23 (½)

= 184 000 J (1)

2

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

kinetic { to / → } heat (1 OR 0)

symbols acceptable 1

NOTES
2 × (1) mark for : one forward labelled <u>and</u> one backward labelled force **(ignore any extra forces in any directions – unless they contradict a correct force)** **NOT <u>wind</u> resistance** **NOT engine <u>power</u>** **accept answer with numbers, if named**
answer based on consequences of NOT wearing seat belt <u>could</u> be worth (2) marks **answer linked to NI — ok**
or m/s/s or $m\,s^{-2}$ or $m\,s^{-1}\,s^{-1}$
NOT movement energy **NOT sound (as well)**

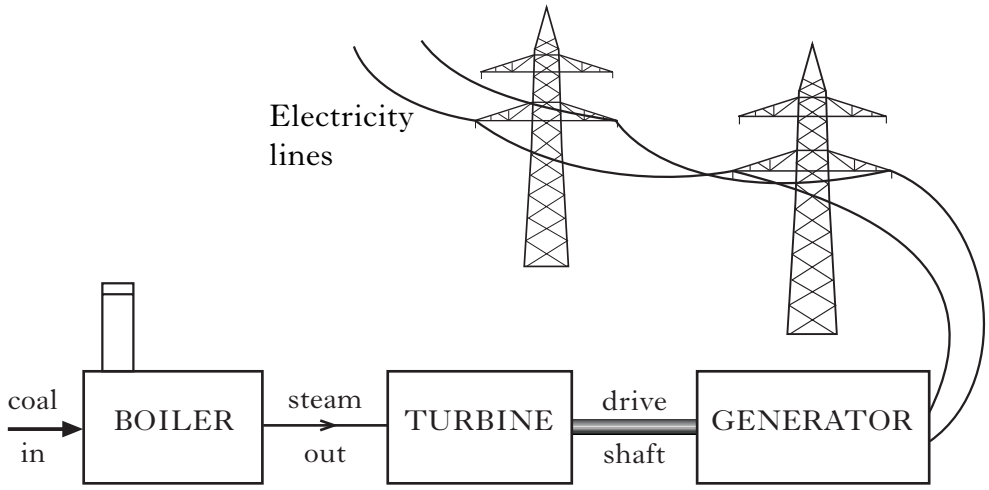
DO NOT WRITE IN THIS MARGIN

	K&U	PS

Marks

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: **chemical** to **heat**

turbine: **heat** to **kinetic**

generator: **kinetic** to **electrical** **(3 × 1)** **3**

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

pollution/finite supply of fuel/non renewable

..... **1**

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

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

{dangerous / harmful} waste products/shielding needed/length of time

needed to store waste/produces radioactive waste **1**

NOTES

NOT stored energy, but accept chemical { **potential** / **stored** } **(energy)**

dotted line applies only if "movement"

accept symbols

NOT "the fuel is radioactive"

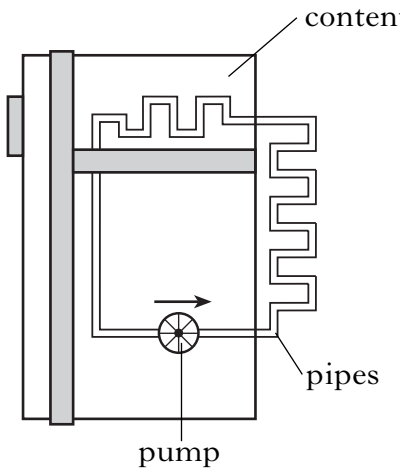
DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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 **C** **1**

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

latent heat (of vaporisation is removed from the contents) **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

E = mcΔT (½)

= 0·75 × 4000 × 17 (½)

= 51 000 J (1)

ΔT = (22 – 5)

= 17 (°C) (1)

3

NOTES

<u>Minimum</u> answer is "latent heat" or a description of what is meant by latent heat.

if 5 or 22 used as $\Delta T \rightarrow$ (½) mark for formula only

any (incorrect) attempt at finding ΔT, which is then used correctly to find E $\rightarrow$ (2) marks

DO NOT WRITE IN THIS MARGIN

K&U	PS

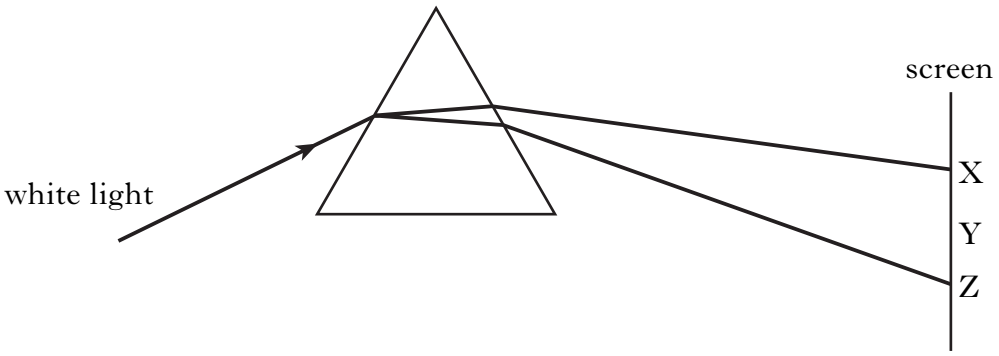
Marks

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?

same speed (in a vacuum) **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?

(triangular) prism **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 **red** **1 correct – 1 mark**

Y **green**

Z **blue** **2**

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

blue **1**

NOTES

accept: value + unit

accept: "the speed of light"

NOT "triangle"

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

20. The table below gives some information about planets and other objects in our Solar System.

	Distance from the Sun (million kilometres)	*Weight of 1 kilogram at the surface (newtons)*
Sun	0	270
Mercury	58	4
Venus	110	9
Earth	150	10
Moon	150	1·6
Mars	228	4
Jupiter	780	26
Saturn	1430	11
Neptune	4500	12

(*a*) Name **one** object in the table that is **not** a planet.

Sun or Moon **1**

(*b*) Which planet is nearest to Earth?

Venus **1**

(*c*) On which **two** planets would a 5 kilogram mass have the same weight?

Mercury and Mars (1 or 0)

..... **1**

NOTES

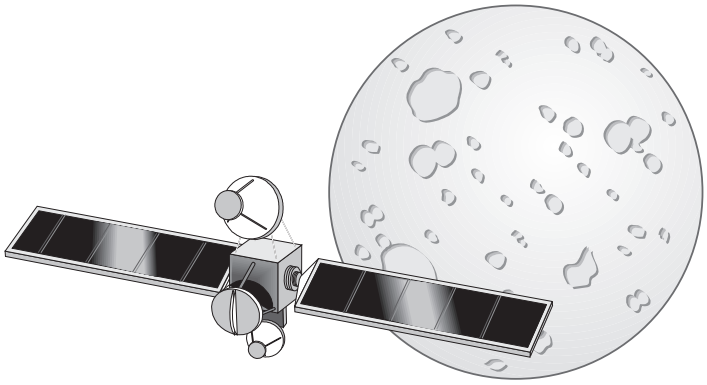
Question No. 20

DO NOT WRITE IN THIS MARGIN

K&U	PS

Marks

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.

solar cell/solar panel(s)/photocell/solar array **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.

Space for working and answer

F = ma (½)

= 420 × 0·2 × 10^{-3} (½)

= 0·084 N (1)

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.

Force acting on the spacecraft is equal { **and** / **but** } **opposite to the** .....

force acting on the gas .....

..... **1**

[*END OF MARKING INSTRUCTIONS*]

NOTES

NOT solar <u>power</u> (not a device)