FOR OFFICIAL USE

Presenting Centre No.	Subject No.	Level	Paper No.	Group No.	Marker's No.
	3220				

C

K & U	PS

Total Marks

3220/102

SCOTTISH CERTIFICATE OF EDUCATION 1999

FRIDAY, 14 MAY
10.50 AM – 12.35 PM

PHYSICS
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of school or college

Town

First name and initials

Surname

Date of birth
Day Month Year

Candidate number

Number of seat

1 All questions should be answered.

2 The questions may be answered in any order but all answers must be written clearly and legibly in this book.

3 Write your answer where indicated by the question or in the space provided after the question.

4 If you change your mind about your answer you may score it out and rewrite it in the space provided at the end of the answer book.

5 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.

6 Any necessary data will be found in the **data sheet** on page two.

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SAB 3220/102 6/3/3/23120

DATA SHEET

Speed of light in materials

Material	*Speed in m/s*
Air	$3{\cdot}0 \times 10^8$
Carbon dioxide	$3{\cdot}0 \times 10^8$
Diamond	$1{\cdot}2 \times 10^8$
Glass	$2{\cdot}0 \times 10^8$
Glycerol	$2{\cdot}1 \times 10^8$
Water	$2{\cdot}3 \times 10^8$

Speed of sound in materials

Material	*Speed in m/s*
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Gravitational field strengths

	Gravitational field strength on the surface in N/kg
Earth	10
Jupiter	26
Mars	4
Mercury	4
Moon	1·6
Neptune	12
Saturn	11
Sun	270
Venus	9

Specific heat capacity of materials

Material	*Specific heat capacity in J/kg °C*
Alcohol	2350
Aluminium	902
Copper	386
Diamond	530
Glass	500
Glycerol	2400
Ice	2100
Lead	128
Water	4180

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion in J/kg*
Alcohol	$0{\cdot}99 \times 10^5$
Aluminium	$3{\cdot}95 \times 10^5$
Carbon dioxide	$1{\cdot}80 \times 10^5$
Copper	$2{\cdot}05 \times 10^5$
Glycerol	$1{\cdot}81 \times 10^5$
Lead	$0{\cdot}25 \times 10^5$
Water	$3{\cdot}34 \times 10^5$

Melting and boiling points of materials

Material	*Melting point in °C*	*Boiling point in °C*
Alcohol	–98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Turpentine	–10	156

Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation in J/kg*
Alcohol	$11{\cdot}2 \times 10^5$
Carbon dioxide	$3{\cdot}77 \times 10^5$
Glycerol	$8{\cdot}30 \times 10^5$
Turpentine	$2{\cdot}90 \times 10^5$
Water	$22{\cdot}6 \times 10^5$

SI Prefixes and Multiplication Factors

Prefix	*Symbol*	*Factor*
giga	G	$1\,000\,000\,000 = 10^9$
mega	M	$1\,000\,000 = 10^6$
kilo	k	$1000 = 10^3$
milli	m	$0{\cdot}001 = 10^{-3}$
micro	μ	$0{\cdot}000\,001 = 10^{-6}$
nano	n	$0{\cdot}000\,000\,001 = 10^{-9}$

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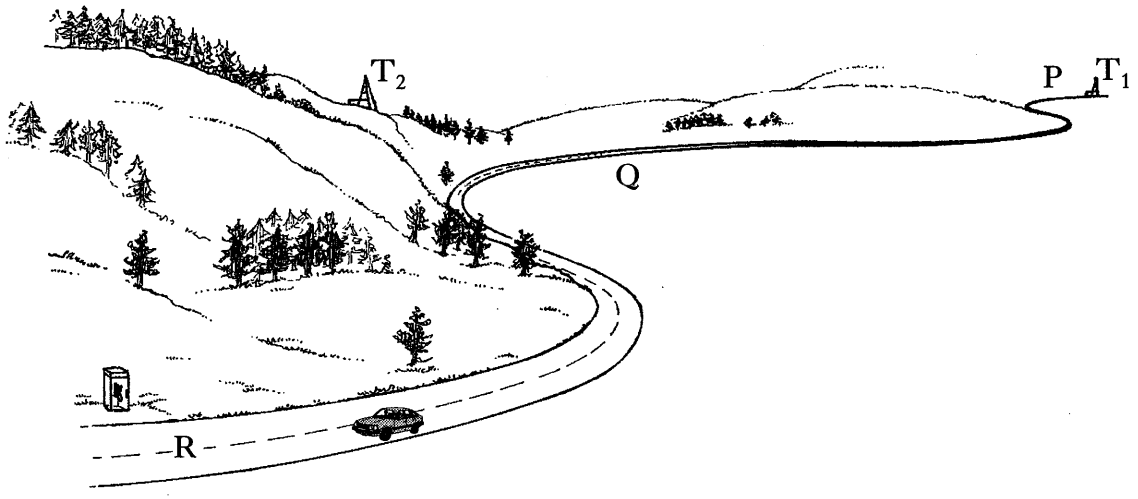
Marks

1. A car passenger receives a call on a mobile telephone while travelling along a road. When the car is at point P in the diagram below, the call is sent from a nearby transmitter T_1.



(*a*) The transmission frequency of T_1 is 900 MHz.

Calculate the wavelength of the radio signal which is used to transmit the call.

Space for working and answer

(2)

(*b*) At another point Q further along the road, a different transmitter T_2 takes over the transmission of the call.

Using information in the diagram, suggest a reason why a different transmitter is used to send the call.

.....

..... **(1)**

[Turn over

K&U	PS

Marks

1. (continued)

(*c*) Further along the road at position R, there is a complete loss of signal when using the mobile telephone. The conversation is continued by making a call from a roadside telephone box.

(i) Assuming the mobile telephone is still working properly, describe what might cause the loss of signal to the mobile telephone.

.....

..... **(1)**

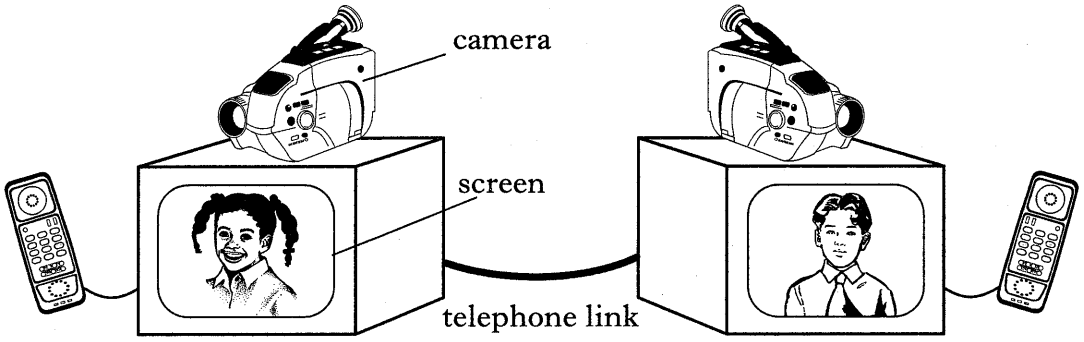
(ii) Explain why there is no loss of signal with the telephone box call.

.....

..... **(2)**

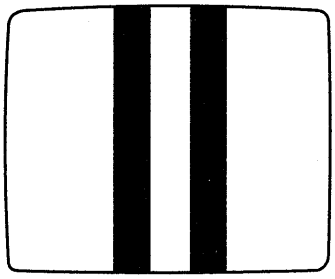
Marks

2. (*a*) At a science exhibition, a display has two videophones connected together.



A videophone is a special telephone which can be used to send both video signals (for pictures) and audio signals (for sound) along a telephone link.

(i) A video signal used to test the link produces the black and white pattern shown.



Describe how a black and white pattern is built up on the screen.

.....

.....

.....

..... **(2)**

(ii) It is only possible to send 3 complete pictures every second along the link to the receiving videophone.

Explain why a person's movement, as seen on the videophone, appears jerky.

.....

.....

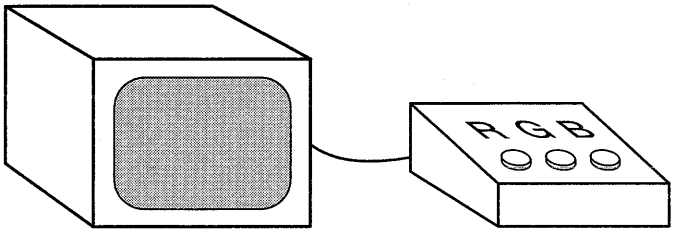
.....

..... **(2)**

Marks

2. (continued)

(*b*) Another display has been set up to show how different colours can be seen on a television screen.



Switches R, G and B on a panel control each of the electron guns in the television. Each switch turns a gun **off** when it is pressed. The colour controlled by each switch is shown in the table below.

Switch	*Colour controlled*
R	Red
G	Green
B	Blue

What colour is the screen when the display is on and

(i) no switches are pressed;

.....

(ii) only switches B and G are pressed;

.....

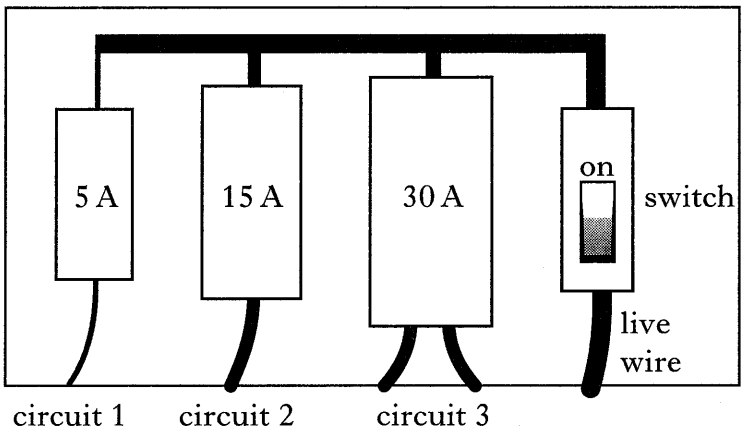
(iii) only switch B is pressed?

..... **(3)**

K&U	PS

Marks

3. The diagram below shows part of a consumer unit in a house. The consumer unit contains fuses for a lighting circuit, a power ring circuit and a water heater circuit, as well as a switch to control all of the circuits. The rating of the fuse used in each circuit is given in the diagram.



(*a*) The switch and the fuses are all connected to the live wire of the electricity supply.

Explain why the switch must be connected to the live wire.

.....

..... **(1)**

(*b*) Explain why identical wire can be used for both circuit 2 and circuit 3 although the fuse used in each circuit has a different rating.

.....

..... **(2)**

(*c*) What is the purpose of the fuses in a consumer unit?

.....

..... **(1)**

(*d*) An electrician replaces all the fuses in this consumer unit with circuit breakers.

Give one advantage of a circuit breaker compared to a fuse.

..... **(1)**

(*e*) Which circuit is the lighting circuit?

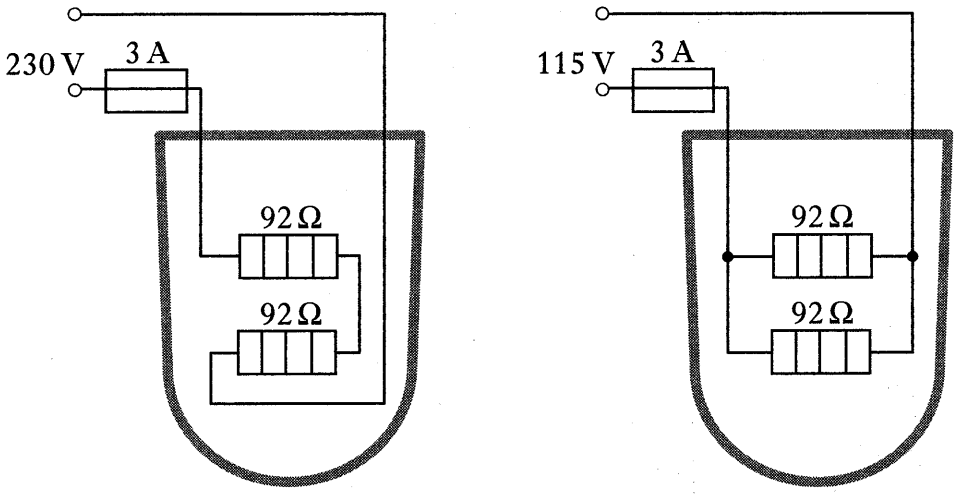
..... **(1)**

[Turn over

K&U	PS

Marks

4. A travel iron is fitted with a 3 A fuse. It contains two identical heating elements, each of resistance 92 Ω. The heating elements of the travel iron can be connected for 230 V operation or for 115 V operation as shown in the diagram below.



230 V operation

115 V operation

(*a*) The travel iron is set for 230 V operation and connected to a 230 V supply. Calculate the power developed by the travel iron.

Space for working and answer

(3)

K&U	PS

Marks

4. (continued)

(*b*) The travel iron is now set for 115 V operation.

(i) Show that the combined resistance of the heating elements is 46 Ω.

Space for working and answer

(2)

(ii) Calculate the current in the travel iron when it is connected to a 115 V supply.

Space for working and answer

(2)

(iii) What will happen if the travel iron is connected to a 230 V supply when it is set for 115 V operation?

Explain your answer.

.....

.....

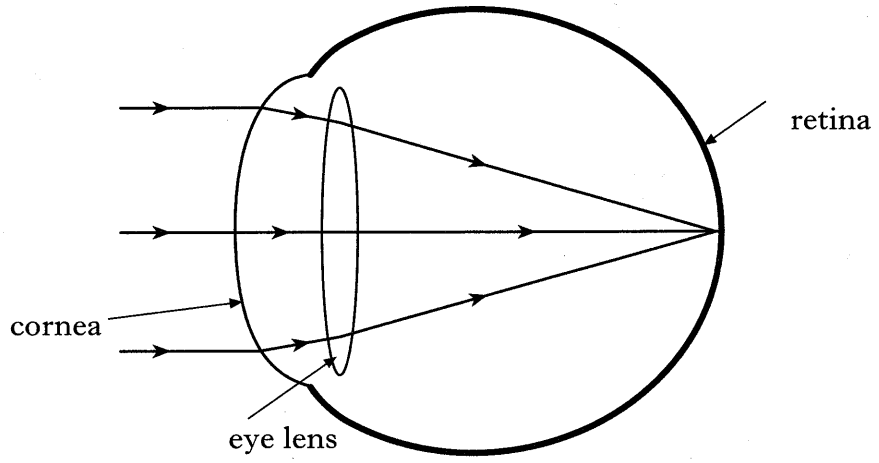
..... **(2)**

[Turn over

K&U	PS

Marks

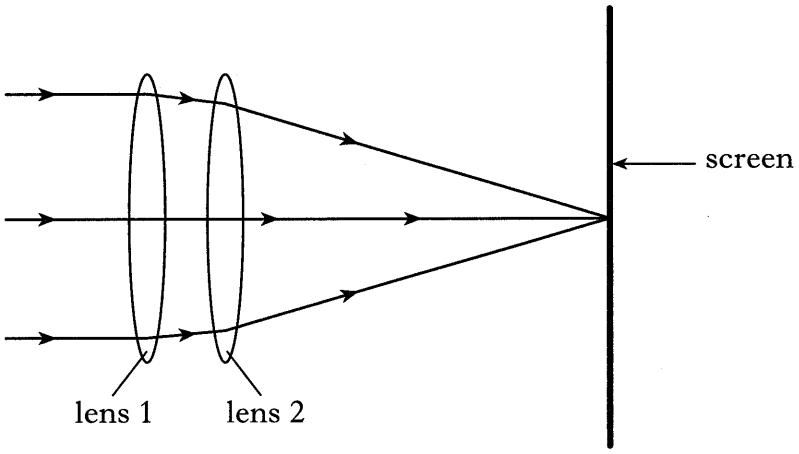
5. In the eye, refraction of light takes place at the cornea and the eye lens.



(*a*) What is meant by refraction of light?

..... **(1)**

(*b*) More of the refraction takes place at the cornea as shown above. To show how the eye forms an image, a student uses two identical lenses and a screen to make a model eye. Three parallel rays of light are directed towards the lenses and are focused on the screen as shown.



State one change that could be made to the lens system to represent more correctly the eye.

Explain your answer.

.....

.....

.....

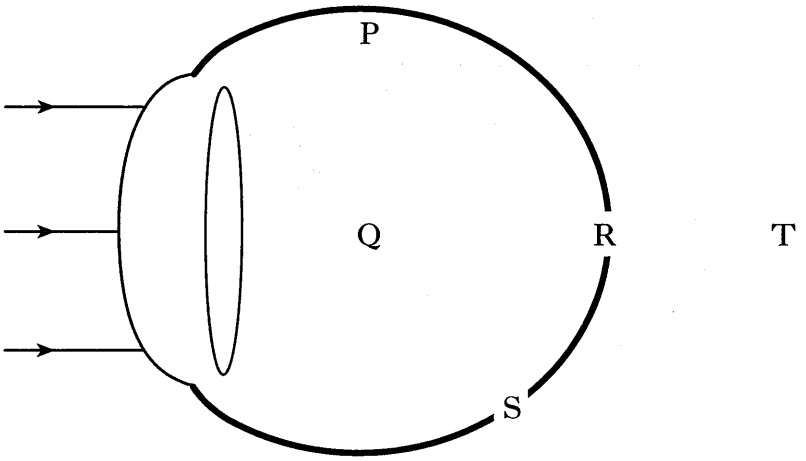
..... **(2)**

Marks

5. (continued)

(*c*) The diagram below represents the eye of a short-sighted person.

(i) On the diagram, circle the letter where all three rays shown would meet.



(1)

(ii) A lens of power −4·0 D is used to correct for this short sight.

(A) What is the shape of this lens?

..... **(1)**

(B) Calculate the focal length of the lens.

Space for working and answer

(2)

(iii) Laser surgery can be used to correct short sight by reducing the curvature of the cornea in the eye.

What effect would the laser surgery have on the focal length of a cornea?

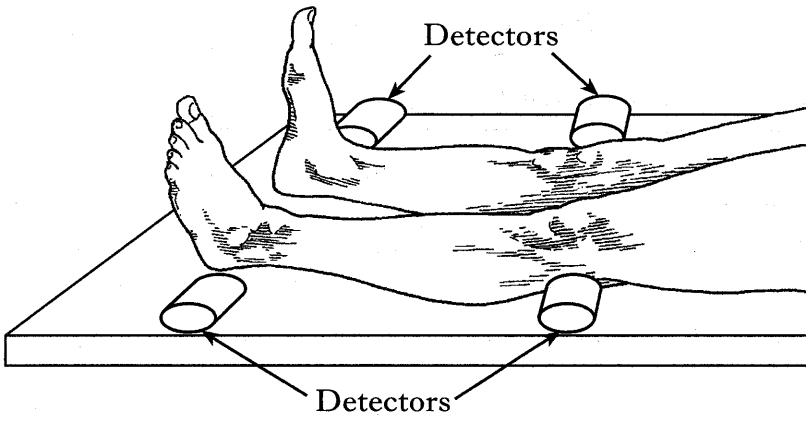
..... **(1)**

[Turn over

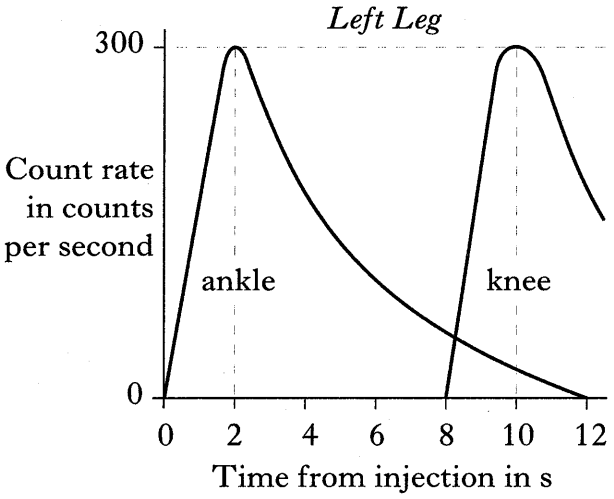
K&U	PS

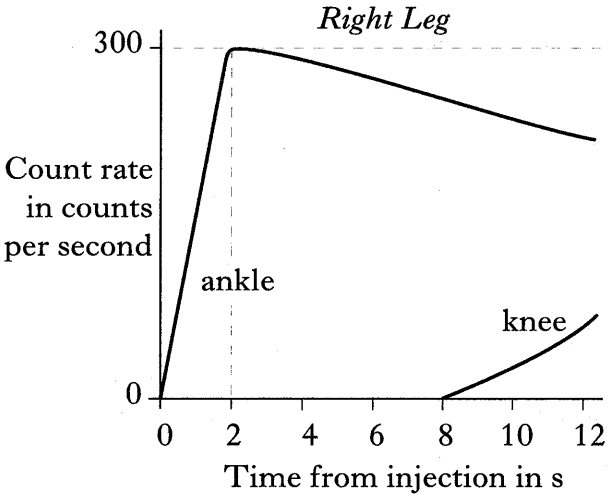
Marks

6. A radioactive tracer is injected into a patient to investigate the rate at which blood flows in the veins of the legs. The tracer is injected into veins in the feet, and detectors are placed beside both ankles and knees of each leg as shown in the diagram.



The graphs show how the count rates at the detectors vary for each leg.





(*a*) The graph obtained for the left leg indicates that the blood flow in that leg is normal.

How long does it take blood to travel from the ankle to the knee in the left leg?

..... **(1)**

(*b*) Explain why the graph obtained for the right leg indicates that there could be a blockage in a vein in the right leg.

.....

.....

..... **(2)**

K&U	PS

Marks

6. (continued)

(*c*) The hospital keeps three radioactive isotopes for different uses. These are shown in the table below.

Isotope	*Half-life*	*Radiation*
Na-24	15·1 hours	gamma
Y-86	14·7 hours	beta
Tc-96	4·3 days	gamma

(i) Which isotope should be selected for the blood flow investigation?

..... **(1)**

(ii) Why are each of the other two isotopes not suitable?

Isotope: .....

Reason: .....

Isotope: .....

Reason: ..... **(2)**

(*d*) The patient could also be given an injection of another isotope Au-79 with an activity of 10 kBq. This isotope has a half life of 2·7 days. The patient must be kept under observation until the activity falls to 1·25 kBq.

Calculate how long this will take.

Space for working and answer

(2)

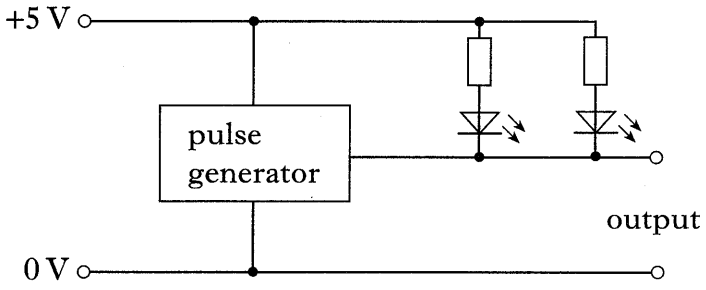
[Turn over

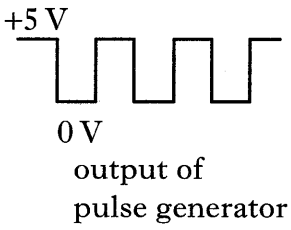
K&U	PS

Marks

7. A model of a black cat with flashing eyes is made for a Halloween party.

Two LEDs which are used as the eyes are connected to a pulse generator as shown in the diagram below. The output of the pulse generator varies as shown.





(*a*) What is the voltage across the output of the pulse generator when the LEDs are lit?

..... **(1)**

(*b*) A resistor is connected in series with each LED.

(i) State the purpose of this resistor.

.....

..... **(1)**

(ii) When lit, each LED has a voltage of 2 V across it and a current of 15 mA in it.

Calculate the value of the resistor in series with the LED.

Space for working and answer

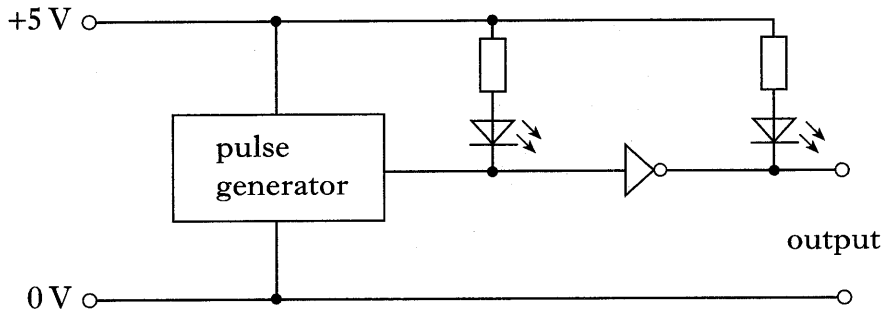
(3)

K&U	PS

Marks

7. (continued)

(*c*) The diagram below shows a change that was made to the circuit.



(i) Name the component that has been added to the original circuit.

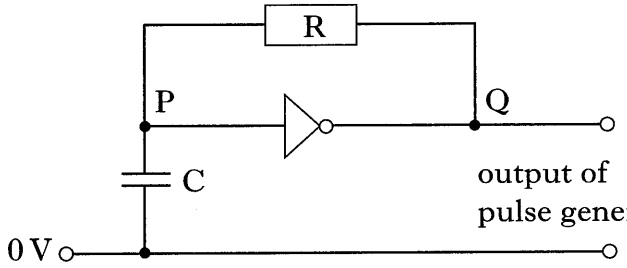
..... **(1)**

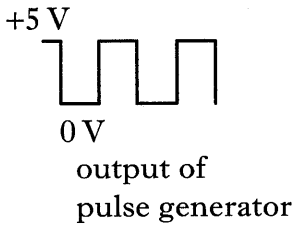
(ii) What effect does this change have on the operation of the LEDs in the circuit?

.....

..... **(1)**

(*d*) The pulse generator circuit is shown in the diagram below. The power supply has not been included in this diagram.





Complete the table to show the voltage at P and at Q when the capacitor in the pulse generator is charged and when it is uncharged.

Capacitor condition	*Voltage at P* (V)	*Voltage at Q* (V)
charged		
uncharged		

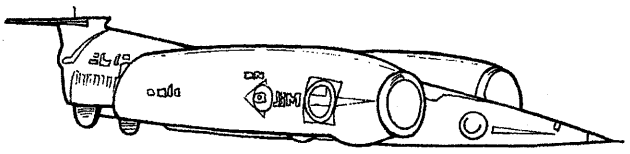
(2)

[Turn over

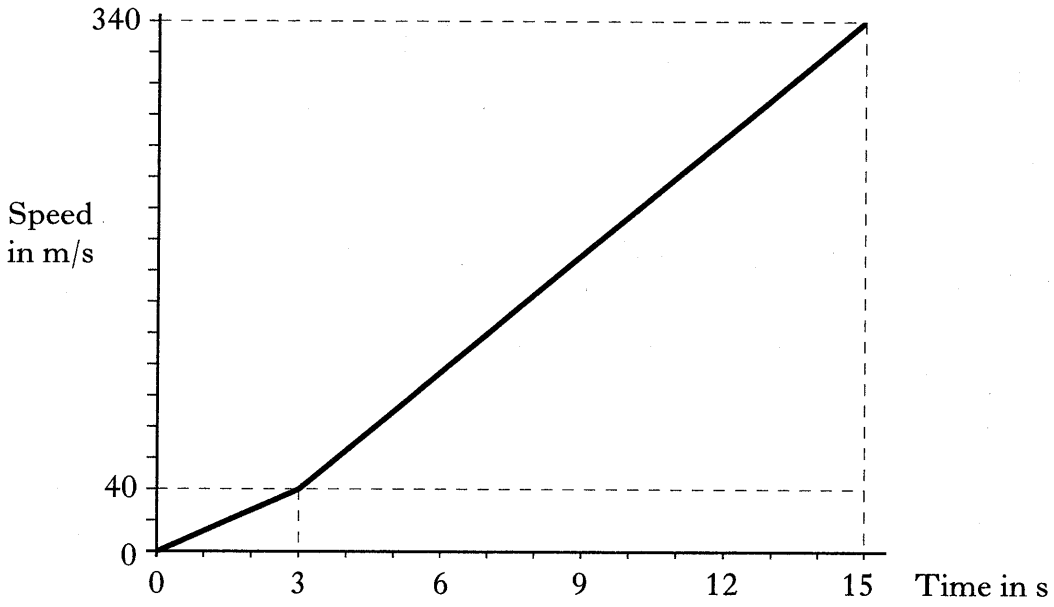
K&U	PS

Marks

8. A jet-engined car of mass 10 000 kg was used to set a land speed record.



The graph shows the speed of the car during the first part of one test run.



(*a*) Calculate how far the car travelled during the 15 s shown.

Space for working and answer

(3)

(*b*) (i) Calculate the maximum acceleration of the car during this part of the test run.

Space for working and answer

(2)

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8. (*b*) (continued)

(ii) Calculate the unbalanced force needed to produce this acceleration.

Space for working and answer

(2)

(iii) During this part of the test run, the force produced by the car's engines was found to be 276 kN.

Calculate the frictional force acting on the car.

Space for working and answer

(2)

(*c*) At the end of the run, the engines were switched off and parachutes attached to the car were used to slow the car down.

Explain how the parachutes slow the car down.

.....

..... **(1)**

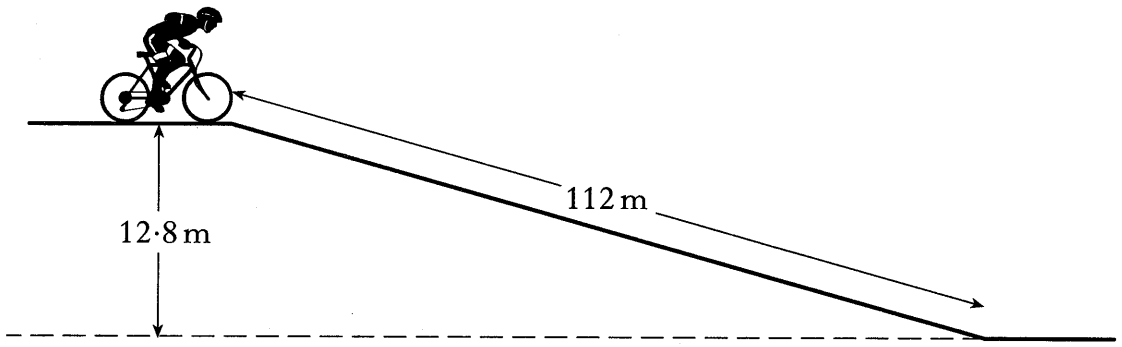
[Turn over

K&U	PS

Marks

9. A cyclist is riding an off-road course. The combined mass of the cyclist and bike is 80 kg.

(*a*) To get to the start of the course the cyclist has pedalled along a slope of 112 m to the top of a hill of height 12·8 m, as shown in the diagram.



(i) Calculate how much potential energy has been gained by the cyclist and the bike at the top of the hill.

Space for working and answer

(2)

(ii) The cyclist then starts from rest and descends the hill without pedalling, keeping the brakes partly on. There is a constant frictional force of 40 N acting up the slope during the descent.

(A) Calculate the amount of work done against friction during the descent.

Space for working and answer

(2)

Marks

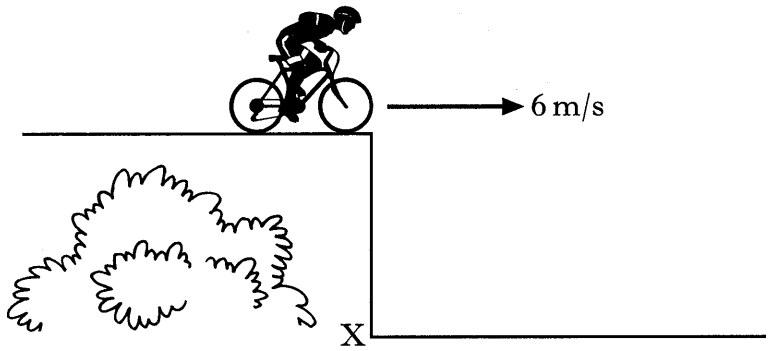
9. (*a*) (ii) (continued)

(B) What is the kinetic energy of the cyclist and bike on reaching the bottom of the hill?

Space for working and answer

(2)

(*b*) In a later section of the course there is a vertical drop. The cyclist leaves the top of the drop travelling horizontally at 6 m/s and reaches the ground 0·4 s later. Air resistance can be ignored.



(i) What happens to the cyclist's horizontal speed during the drop?

..... **(1)**

(ii) What happens to the cyclist's vertical speed during the drop?

..... **(1)**

(iii) Calculate how far from point X the cyclist lands.

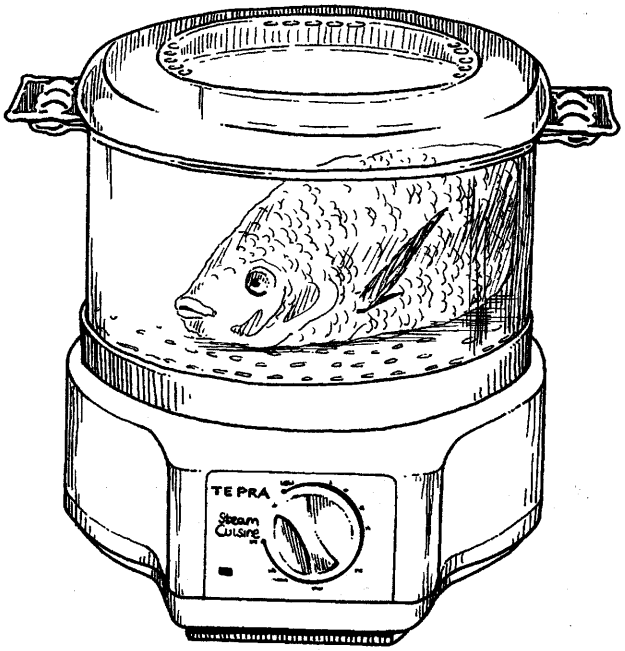
Space for working and answer

(2)

K&U	PS

Marks

10. A chef uses an electric steamer to cook a fish. The steamer heats water, causing steam to rise through holes in the base of the food compartment.



The steamer is rated at 600 W and contains 0·5 kg of water at a temperature of 20 °C.

(*a*) Calculate the energy needed to raise the temperature of the water from 20 °C to 100 °C.

Space for working and answer

(3)

(*b*) The fish has to be steamed for 8 minutes after the water has reached its boiling point of 100 °C.

(i) Calculate the energy supplied to the steamer in the 8 minutes.

Space for working and answer

(2)

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Marks

10. (*b*) (continued)

(ii) Calculate the maximum mass of water that could be converted to steam in this time.

Space for working and answer

(3)

(iii) Energy is needed to cook the fish. This energy comes from the steam when it changes to water.

Complete the following passage by using the words **heat** and **temperature**.

When steam changes to water, it loses ..... but its

..... does not change. **(1)**

[Turn over

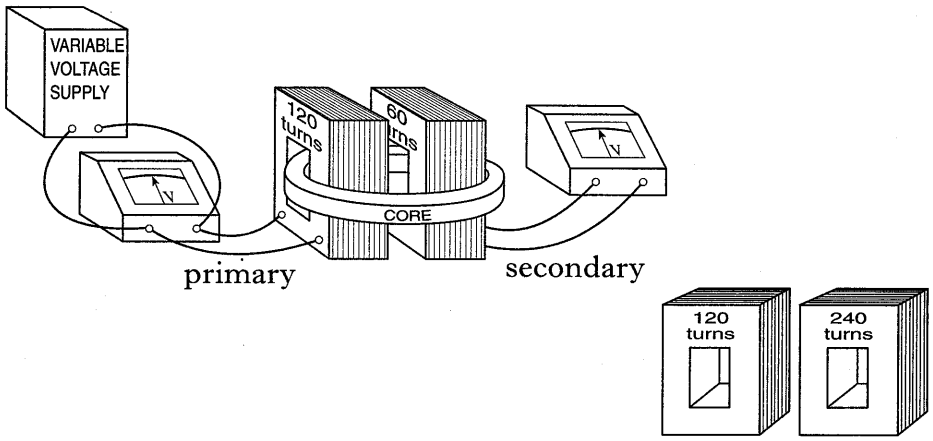
K&U	PS

Marks

11. A pupil uses a 120 turn coil as the primary of a transformer.

Three other coils, one of 60 turns, one of 120 turns and one of 240 turns are used separately as the secondary of the transformer.

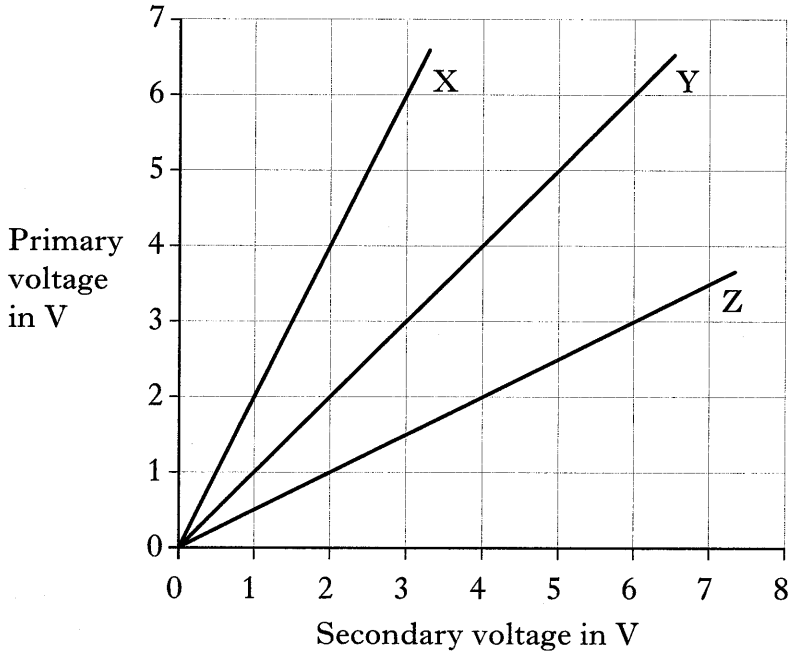
A variable voltage supply and voltmeters are connected as shown in the diagram.



The voltage of the supply is varied.

For each secondary coil in turn, voltmeter readings are taken of the voltage across the primary and the corresponding voltage across the secondary.

The lines X, Y and Z on the graph are obtained by plotting these readings.



(*a*) (i) There is a choice of either a.c. or d.c. voltmeters.

Which type should be used in this experiment?

Explain your answer.

.....

..... **(2)**

K&U	PS

Marks

11. (*a*) (continued)

(ii) Complete the table below using information from the graph.

	Primary voltage (V)	*Secondary voltage* (V)
line X	2	
line Y	2	
line Z	2	

(3)

(iii) Which of the lines X, Y or Z shows the results for a step down transformer?

..... **(1)**

(iv) Which coil did the pupil use as the secondary coil in the transformer to produce line Z?

Support your answer with a calculation.

Space for working and answer

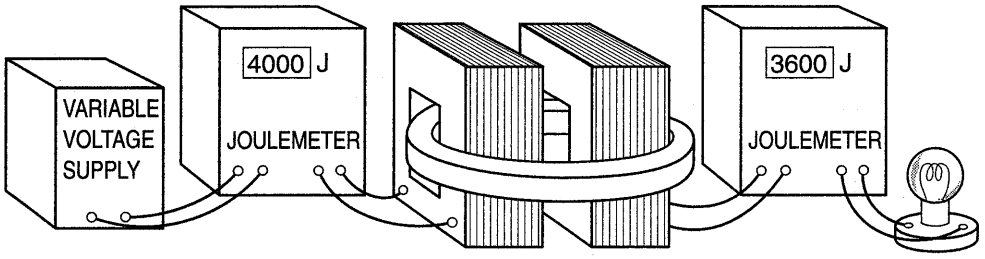
(2)

[Turn over

Marks

11. (continued)

(*b*) The pupil investigates the efficiency of transformers using a transformer, two joulemeters and a lamp connected to a supply as shown.



Initially, the displays on both joulemeters are set to zero. The supply is switched on and after a certain time the readings shown are obtained.

(i) Calculate the percentage efficiency of this transformer.

Space for working and answer

(2)

(ii) Give a reason why transformers are not 100% efficient.

.....

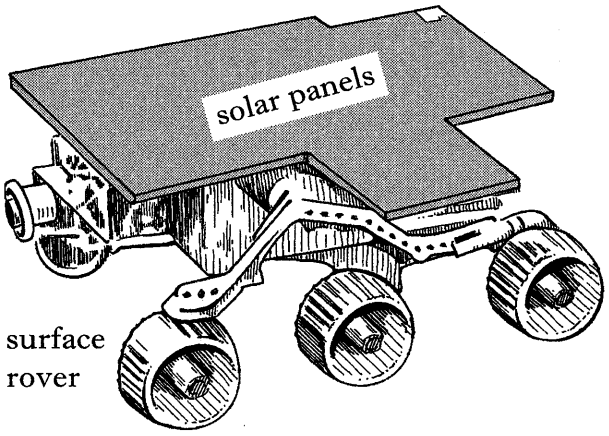
..... **(1)**

K&U	PS

Marks

12. Read the following article.

The planet Mars is the fourth planet out from the Sun in our solar system. Mars has very little atmosphere and because of this, its surface is exposed to high levels of ultraviolet radiations.



In July 1997 Mars Pathfinder landed on the surface of the planet. Pathfinder consisted of a stationary lander and a mobile surface rover. The lander was in constant communication with Earth and there was a UHF radio communications link between the lander and the surface rover.

The surface rover, of mass 10·5 kg, was powered by solar panels with a total area of 0·2 m^2 as shown in the diagram. It carried various instruments including an X-ray spectrometer which was used to carry out tests on the surface of the planet.

(*a*) The passage mentions by name three radiations in the electromagnetic spectrum.

List these radiations in order of **increasing** wavelengths.

Radiation 1	*Radiation 2*	*Radiation 3*
Shortest wavelength	⟶	Longest wavelength

(2)

(*b*) Solar radiation provides 65 W of power to each square metre of the surface of Mars.

(i) Calculate the maximum power output of the solar panels on the surface rover on Mars.

Space for working and answer

(2)

[Turn over for Question 12(*b*) on *Page twenty-six*

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Marks

12. (*b*) (continued)

(ii) Give one advantage of using solar panels instead of batteries to power the surface rover.

.....

..... **(1)**

(*c*) Calculate the weight of the surface rover on Mars.

Space for working and answer

(2)

[*END OF QUESTION PAPER*]

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