SCOTTISH QUALIFICATIONS AUTHORITY

1998 Physics SG Credit
Detailed Marking Instructions

Strictly Confidential

These instructions are **strictly confidential** and, in common with the scripts entrusted to you for marking, they must never form the subject of remark of any kind, except to Scottish Qualifications Authority staff. Similarly, the contents of these instructions must not be copied, lent or divulged in any way now, or at any future time, to any other persons or body.

Markers' Meeting

You should use the time before the meeting to make yourself familiar with the question paper, instructions and any scripts which you have received. Do **not** undertake any final approach to marking until **after** the meeting. Please note any points of difficulty for discussion at the meeting.

Note: These instructions can be considered as final only after the markers' meeting when the full marking team has had an opportunity to discuss and finalise the document in the light of a wider range of candidates' responses.

Marking

The utmost care must be taken when entering and totalling marks. Where appropriate, all summations for totals must be carefully checked and confirmed.

Where a candidate has scored zero marks for any question attempted, "0" should be entered against the answer.

Recording of Marks

The mark for each **question**, where appropriate, should be entered **either** on the grid provided on the back page of the answer book, **or** in the case of question/answer books, on the grid (if provided) on the last page of the book. Where papers assess more than one element, care must be taken to ensure that marks are entered in the correct column.

The **Total** mark for each paper or element should be entered (in red ink) in the box provided in the top-right corner of the front cover of the answer book (or question/answer book).

Always enter the **Total** mark as a **whole number**, where necessary by the process of rounding up.

The transcription of marks, within booklets and to Form Ex6, should always be checked.

98miphys.csg

15 May 1998

GENERAL INSTRUCTIONS

1. Knowledge and Understanding and Problem Solving marks **must be entered** in the separate columns in the right hand margin of the candidates answer booklet.

2. Please enter the mark, carefully, including a zero mark, for each item, at the position indicated in the appropriate column.

3. Total marks, **rounded up** to a **whole number**, for both Knowledge and Understanding and Problem Solving should be entered in the appropriate box at the front of the Candidate's script.

4. Where 1 mark is shown for the final solution of a numerical problem, a ½ mark is allocated for the correct unit unless there is a statement to the contrary in the scheme.

5. Where a final numerical answer to a problem is given by the candidate in the form 6^3, for example, instead of 6×10^3, deduct ½ mark.

6. Where a relationship is written down in a "triangle" format and then not used or used incorrectly, the ½ mark, which is generally allocated to the relationship is not awarded.

7. Marks not awarded because of a candidate's incomplete answer should be indicated by an omission sign on the script i.e. /.

8. Partial marks as indicated by the scheme may be awarded up to the point where candidate makes a mistake. However, for those parts of the scheme separated by a dotted horizontal line, the candidate's wrong answer relating to the part of the scheme above the line, if carried forward correctly, may gain marks for that part of the scheme below the dotted line.
A final answer, now deemed correct, after using a wrong figure from a previous answer should be indicated by underlining with a wavy line ~~~.

9. Deduct ½ mark for an arithmetical error.

10. If a correct answer from a calculation is converted in the last line of the calculation to an answer which uses a wrong multiple or submultiple of a unit then deduct ½ mark. For example, if the final line involves the conversion 2.2×10^{-4} m = 22 mm then deduct ½ mark.

11. In questions calling for a specific number of reasons or examples to be given and the candidate gives more than is required, wrong responses cancel out correct ones. For example in a question worth 2 marks, asking for two reasons (each worth 1 mark) to be given and three reasons are provided by the candidate, one of which is wrong, then only one out of the two available marks is awarded.

"The Standard Two Marker"

Example.

Calculate the current in a 20Ω resistor when a voltage of 5 V is applied.

1. Correct solution

$V = I.R$	½ for formula	
$5 = I.20$	½ for substitution	
$I = \frac{5}{20}$		
$= 0.25$ A	1 for answer	2 marks

2. Arithmetic slip

$V = I.R$	½ for formula	
$5 = I.20$	½ for substitution	
$I = \frac{5}{20}$		
$= 4$ A	Deduct ½ for arithmetic	1½ marks

i.e. transformation must be shown to be correct and then arithmetic slip made.

3. Unit omission or wrong.

$V = I.R$	½ for formula	
$5 = I.20$	½ for substitution	
$I = \frac{5}{20}$		
$= 0.25$ or 0.25 V	Deduct ½ for unit	1½ marks

4. Correct substitution followed by wrong transposition.

$V = I.R$	½ for formula	
$5 = I.20$	½ for substitution	
$I = \frac{20}{5}$	Stop marking	1 mark

5. Wrong substitution

$V = I.R$	½ for formula	
$20 = I.5$	Stop marking	½ mark

6. Wrong transposition

$V = I.R$	½ for formula	
$I = \frac{R}{V}$ or $\frac{20}{5}$	Stop marking	½ mark

Marks

1. Information may be passed between a telephone exchange and a receiver in a number of ways.

(a) Electrical signals from the telephone exchange are converted to light signals. The light signals are then transmitted through an optical fibre to the receiver.

Complete the diagram in figure 1 to show the path of a ray of light as it passes along the optical fibre.

If angle of incidence not approx equal to angle of reflection then 0-mark

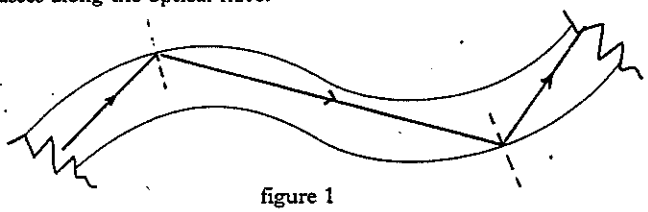


figure 1 (1)

(b) Electrical signals from the telephone exchange are converted to microwaves. The microwaves are transmitted via a satellite to the receiver as shown in figure 2.

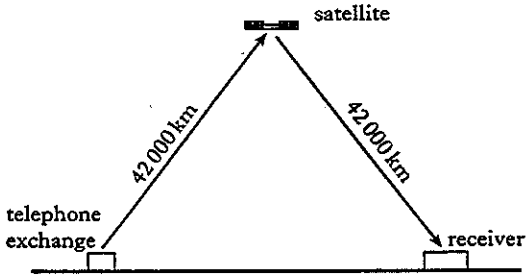


figure 2

Calculate the time taken for the microwave signal to travel from the telephone exchange to the receiver.

If any other value of v used then max ½ for formula

Space for working and answer

$v = 3 \times 10^8$ m/s (1)

$v = \frac{d}{t}$ (½) $\quad t = \frac{d}{v}$

$3 \times 10^8 = \frac{84\,000 \times 10^3}{t}$ (½)

$t = \frac{84\,000 \times 10^3}{3 \times 10^8} = 0.28\text{ s}$ (1)

(3)

If $d = 84\,000$ deduct ½.
$d = 42\,000$ max 1½/3.

[Turn over

NOTES

Max 5 reflections No ½ marks
Some error allowed

If 3×10^8 appears give data mark (1)

Any other v from speed of light data table then can get 2 out of 3

½ off if 300 000 m/s used.

Question No. 1

Marks

2. (*a*) Firefighters use special viewers which detect radiations from one part of the electromagnetic spectrum marked Q in figure 1.

Gamma rays	X-rays	P	Visible	Q	Micro-waves	TV	Radio

figure 1

(i) Name radiation Q.

Infrared (1) ..... (1)

(ii) Describe how the viewer is able to detect an unconscious person in a dark, smoke-filled room.

Viewer detects {different / higher / maximum / greater} {colour / infrared reading / radiation Q} (½) .....

..... (½)

when pointing towards unconscious person ..... (1)

(*b*) The display screen on the viewer produces a black and white picture.
A pupil suggests that it would be better to produce a colour picture on the screen using a system of phosphor dots which can emit red, green or blue light.
Which dots would glow to produce cyan on the display screen?

Blue and Green (1) ..... (1)

No ½ marks

NOTES

Not Heat

Body Must be mentioned.
Body gives out IR ½ (accept heat)
{Picked up by Viewer / penetrates smoke} ½

or
Body gives out more IR ½
than surroundings ½

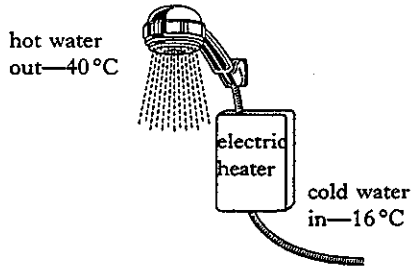
or Body at different/higher temp ½
Than surroundings ½

Not works like a thermogram

Question No. 2

Marks

3. An electric shower unit is supplied with cold water at a temperature of 16 °C as shown below. An electric heater in the unit is used to increase the temperature of the water so that it comes out of the shower at 40 °C. The shower provides 5 kg of hot water every minute.



(*a*) Calculate the heat energy supplied to the water every minute.
[specific heat capacity of water = 4 180 J/kg °C]

Space for working and answer

$E_H = c\,m\,\Delta T$ ½
$= 4180 \times 5 \times (40-16)$ ½
$= 501\,600$ J ① 501·6 kJ
or (502 000 J or 5.02×10^5 J)

(2)

(*b*) Calculate the power output of the heater **in watts.**

Space for working and answer

$P = \frac{E}{t}$ ½
$= \frac{501\,600}{60}$ ½
$= 8360$ (W) ① (or 8400 (W))

(2)

(*c*) The manufacturer of the shower states that the flow rate may have to be adjusted in winter if a hot water temperature of 40 °C is to be maintained. Explain whether the flow rate would be greater or less than 5 kg per minute.

Cold water enters at lower temp (in winter) ①
or temperature rise greater ½ ①
hence flow rate would be less ①

(2)

NOTES

If use 4200 deduct ½ mark

units given Dotted line

½ given in kW deduct ½

Greater flowrate followed by cold water enters at lower temp — 0/1 mark

Lower flow rate ① + explanation which must include temp ①

Question No. 3

flow rate less 1 mark only with attempted explanation

Marks

4. A car starter motor is operated when the driver closes the ignition switch.

Figure 1 shows the system used to operate the starter motor.

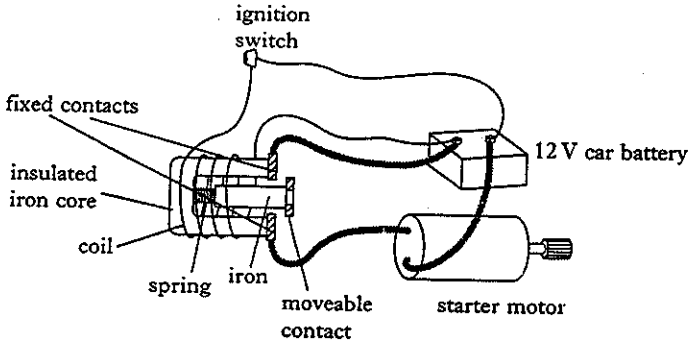


figure 1

(a) Explain why closing the ignition switch makes the starter motor operate. (½)

When ignition switch is closed there is a current in the coil (½)
This creates a magnetic field around the coil which attracts (½)
iron into coil. The moveable contact closes gap (½)
completing motor circuit and motor turns (½) (3)

6 x (½)

(b) The voltage across the cable connecting the battery to the starter motor is 0·25 V when the current in the cable is 400 A. The cable has a resistance of 5×10^{-4} ohm per metre.

Calculate the length of this cable.

Space for working and answer

$V = IR$ (½)

$0.25 = 400 \times R$ (½)

$R = \frac{V}{I}$ $R = \frac{0.25}{400} = 6.25 \times 10^{-4}$ (Ω) (1)

length $= \frac{6.25 \times 10^{-4}}{5 \times 10^{-4}} = 1.25\,m$ (1)

(3)

note is $6{\cdot}25 \times 10^{-4}$ m is final answer - max 1½

[3220/102]

6

NOTES

Mark each point independently

(a) Main points to be noted: When ignition switch is closed

- current in coil
- magnetic field around coil
- iron attracted into coil
- moveable contact closes gap
- motor circuit complete
- motor turns or comes on etc. 6 x (½)

} coil becomes electromagnet 2 x ½

or voltage across coil

If calculation stops at resistance then Ω unit must be there.

~~Check~~ Allow rounding

Allow

Question No. 4 (a)/(b)

4. **(continued)**

Marks

(*c*) A diagram of the starter motor is shown in figure 2.

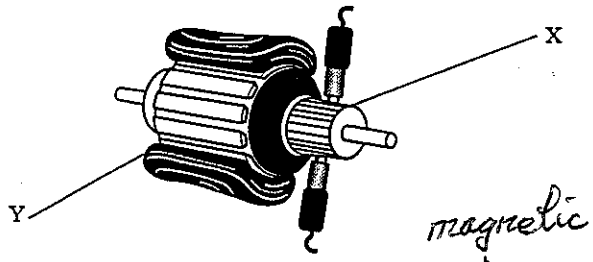


figure 2

magnetic coils or Stator or electromagnet

Name the parts labelled X and Y on the diagram.

X Commutator (½) Y Field coil(s) (½) **(1)**

(*d*) When the starter motor operates, a charge of 360 C is drawn from the battery.

How long will it take to recharge the battery if a charging current of 5 A is used?

Space for working and answer

$Q = It$ (½)

$360 = 5t$ (½)

$t = \frac{Q}{I}$ $t = \frac{360}{5} = 72s$ (1)

(2)

[Turn over

NOTES

Don't penalise spelling

Question No. 4(c)(d)

Marks

5. An illuminated food cabinet, used in a canteen, has warm and hot areas as shown in figure 1. Separate heating elements provide heat for the warm and hot areas.

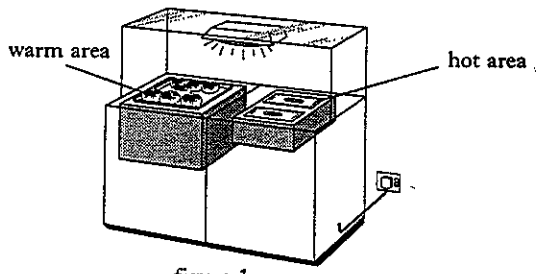


figure 1

The heating elements and lamp are connected to the 230 V mains supply as shown in figure 2. The resistance of each heating element and the lamp is indicated in figure 2.

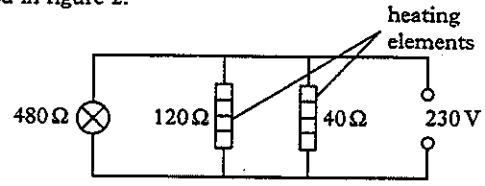


figure 2

(a) Calculate the power of the lamp.

Space for working and answer

$P = \frac{V^2}{R}$ (½) OR $V = IR$

$= \frac{(230)^2}{480}$ (½) $230 = I \times 480$ (½)

$(I = 0.479\,A)$

$P = VI$ (½)

$= 230 \times 0.479$

$= 110\,W$ (1) $= 110\,W$ (1)

or (110.2 W)

(2)

(b) Calculate the combined resistance of the lamp and the heating elements.

Space for working and answer

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (½)

$= \frac{1}{480} + \frac{1}{120} + \frac{1}{40}$ (½)

$= \frac{1+4+12}{480}$ OR 0.00208 + 0.025 + 0.0083

$= 17/480$ OR 0.0354

(2)

$R = \frac{480}{17} = 28.2\,\Omega$ (1) OR $R = \frac{1}{0.0354} = 28.2\,\Omega$

NOTES

or $P = I^2R$ (½)

$= (4.79^2) \times 480$

$= 110\,W$ (1)

Allow rounding

allow ½ for this formula if it appears.

Allow other marking if correct

(b) If $R = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ and later invert i.e correctly complete RHS - deduct ½ mark.

If $R = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ and do not invert - 0 mark

Give ½ mark for substitution only if formula correctly stated

Question No. 5(a)/(b)

5. **(continued)** *Marks*

(c) Calculate the current drawn from the supply when the cabinet is operating.

Space for working and answer

$V = IR$ (½)

$230 = I \times 28.(2)$ (½)

$I = \frac{V}{R}$ $\quad I = \frac{230}{28}$

$= 8.2\text{A}.$ (1)

(2)

or $I_1 = \frac{V}{R}$ (½) $= \frac{230}{480} = 0.48\text{A}$

$I_2 = \frac{V}{R} = \frac{230}{120} = 1.92\text{A}$ (½)

$I_3 = \frac{V}{R} = \frac{230}{40} = 0.75\text{A}$

$\therefore I = 8.15\text{A}$ (1)

[Turn over

NOTES

Insert dotted line

ie formula (½) substitutions (½)

final answers (1)

Deduct ½ mark for each error in substitutions up to max 1½

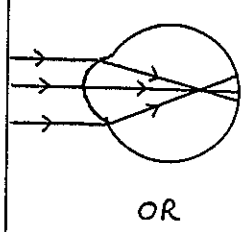
Question No. 5(c)

Marks

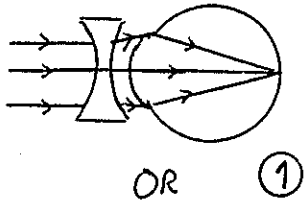
6. A motorist has to wear spectacles to read the number plate on a car which is 20 m away. However, the information on the instrument panel in a car can be read easily by the motorist without wearing spectacles.

(a) Explain whether the spectacle lenses are convex or concave.
(You may draw diagrams to illustrate your answer if you wish.)

Space for answer



OR (1)



OR (1)

Without spectacles light is brought to a focus in front of retina

With spectacles light is brought to a focus on retina

hence concave lenses (1) [if state concave alone - ½ mark]

(If state person short sighted - ½ mark)

(3)

1st Mark

2nd Mark

(b) The focal length of one of the spectacle lenses is 67 cm.
Calculate the power of the lens.

Space for working and answer

$P = \frac{1}{f}$

$= \frac{1}{0.67}$ Accept (−1.5)

$= (-)1.49$ – negative since concave.

~~Deduct ½ mark if degree omitted~~

(2)

½ mark for formula only if f left in cm.

NOTES

or person shortsited (1) ↔ order does not matter

so use concave lens (1)

reason for using concave lens (1)

Draw convex lens – 0 marks

Divergence in diagram not necessary

Can get from label on diagram

K&U | PS

Marks

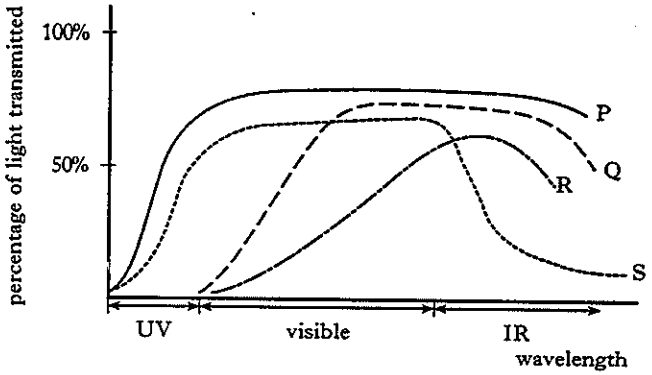
7. Read the following passage about eye protection.

Certain groups of people may be exposed to high levels of ultraviolet light. Their eyes must be protected. Spectacle lenses can be treated with special coatings to give protection.

Scientists who regularly use illuminated microscopes must use protective spectacles. These must allow the maximum transmission of visible light but protect against ultraviolet light.

People taking part in winter sports also require spectacles to protect their eyes from ultraviolet light. The spectacles also cut down light received from the sun and reflected from the snow.

The graphs P, Q, R and S below provide information on spectacle lenses with four different coatings.



(*a*) Which spectacle lens should be used by scientists using illuminated microscopes? Give a reason for your answer.

Q lens absorbs (or does not transmit) UV (1)
but transmits a high percentage of visible light (1)

(2)

(*b*) Which spectacle lens should be used by people taking part in winter sports? Give a reason for your answer.

R (1) lens absorbs (or does not transmit) UV (1)
but transmits a low percentage (or cuts down) visible light (1)

(2)

Reason

[Turn over

NOTES

Mark for explanation S - independant

P - maximum transmission of visible light (1)
- some protection from UV (1)

S - good transmission of visible light (1)
- some protection against UV (1)

R - Protects against UV (1) only

Q - (1) lens absorbs / does not transmit UV (1)

P (1) - gives maximum transmission of visible light (1)

Ignore all other answers

Question No. 7

K&U | PS

Marks

8. Doctors use radioactive technetium to investigate different parts or the human body. A solution of technetium is injected into the body and a gamma camera is used to detect the radiation emitted.

(*a*) The half-life of technetium is 6 hours.
What is meant by the term "half-life"?

Time taken for the activity of the source to half (1)

OR Time taken for half of the atoms in the source to decay

..... (1)

(*b*) The table below indicates the minimum activity of the technetium solutions which are used to investigate various parts of the body.

Part of body to be investigated	*Minimum activity of solution* (MBq)
Brain	800
Lungs	80
Liver	200
Thyroid	40

A solution is made up with 800 MBq of technetium at 8 am.

(i) What is the latest possible time that the solution could be used for investigating a patient's liver?

Space for working and answer

800 ⟶ 400 ⟶ 200 (½)

ie 2 half lives

∴ Time to reach 200 MBq = 2 × 6 = 12 h (1)

∴ Latest time = 8 pm (20.00) (½)

ie (2)

(ii) At 10 pm, which part or parts of the body listed in the table could still be investigated using the solution? Explain your answer.

Part of body (1) Lungs ½ and Thyroid ½ since ✓

Reason for elimination (1) after 8 pm activity is less than (200 MBq) (1)

Reason for choice (1) but at 2 am next day (or after 12 h) activity will still be (100 MBq) (1) (or is still above 80 Bq) (3)

[3220/102]

12

NOTES

Not time for radioactivity to half / could take to half / mass to half

corrected count rate OK – can be implied

give ½ mark for some indication of halfing

Dotted lines ✓

(b)(ii) Possible common error in (i) will be 800 - 400 - 200 ---- 3 half lives ---- 18h ---- 2.00 a m

Just use marking scheme ~~(1) t/reason~~ so answer for (ii) at 10 pm is liver, lungs and thyroid ~~award max (2)~~ (3)

or activity is too small for brain & liver but high enough for lungs & thyroid

Question No. 8(a)(b)

K&U PS

Marks

8. (continued)

(*c*) The third column in the table below lists values which give a measure of the biological effect of the radiation on the absorbing tissue.

Part of body to be investigated	*Minimum activity of solution* (MBq)	Dose equivalent (1) ..... (Sievert (Sv)) (1)
Brain	800	0·0170
Lungs	80	0·0003
Liver	200	0·0027
Thyroid	40	0·0020

Accept mSv μSv ~~KSV~~ MSv

Complete the table by adding the name and unit of the quantity whose value is listed in the third column. **(2)**

[Turn over

NOTES

Mark independantly

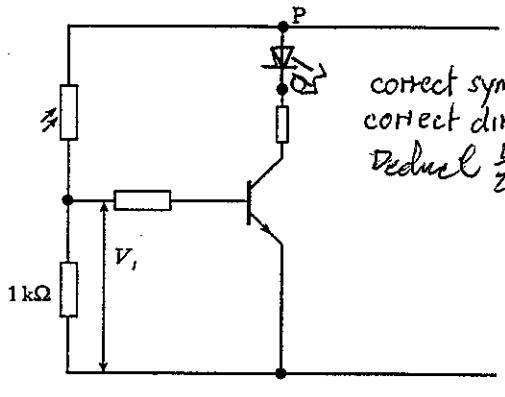
Accept variations in spelling

K&U | PS

Marks

9. A pupil is asked to devise a circuit which will switch on automatically a light emitting diode (LED) when a room becomes dark.

Part of the circuit the pupil sets up is shown in the diagram below.



correct symbol ½ (1)
correct direction ½
Deduct ½ for wrong direction

(*a*) Complete the circuit diagram above to show a LED correctly connected between P and Q. (1)

(*b*) The properties of the light dependent resistor (LDR) in the circuit used by the pupil are shown in the table below.

Lighting conditions	*Resistance of LDR*
Bright	100 Ω
Dark	10 kΩ

V_1 is the input voltage to the transistor. The transistor switches on fully when V_1 rises above 0·7 V.

(i) Calculate the value of the input voltage V_1 in dark conditions. (Use an appropriate number of figures in your answer.)

Space for working and answer

$\frac{V_1}{V_S} = \frac{R_1}{R_T}$ (½)

$\frac{V_1}{5} = \frac{1000}{11000}$ (½)

$V_1 = \frac{5 \times 1000}{11000} = 0,45\text{V}$ OR 0,5V or 0,455V (3)

Ans + Sig Fig
(1) + (1)

Wrong rounding-no deduction

NOTES

Must have arrows

Wrong physics – 0

0·5 Alone – 0 ~~stop marking~~

~~Sig Fig Mark separately~~

$V = IR$ (½)

$I = \frac{V}{R} = \frac{5}{11 \times 10^3} = 4{\cdot}5 \times 10^{-4}\,(A)$ (½)

Continue of arithmetic error only

$V = IR$

$= 4{\cdot}5 \times 10^{-4} \times 1 \times 10^3$

$= 0{\cdot}45\text{ V}$ + (1) sig fig

(1)

No allowance for rounding

9. (*b*) **(continued)**

(ii) When the room is dark and the LED is correctly connected, it will **not** light. Explain.

(When room is dark)
V_1 is less than 0·7V ① (1)
transistor is switched off (1) (and so there is
no current through LED) (1) (2)

(*c*) Using only the components shown in the circuit diagram, state one change which should be made to the circuit to make it operate properly. ①

Reverse position of LDR and 1kΩ resistor (1)

[Turn over

Marks | K&U | PS

NOTES

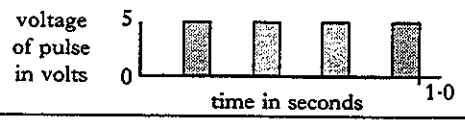
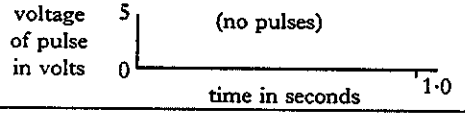
or V_1 is only 0·45 volts
0·7 volts must be given

Must say 1k resistor

K&U PS

Marks

10. A driverless train is operated by sending voltage pulses of different frequency along the railway track to a motor control in the train. The different frequencies of pulse that are used to give different instructions to the motor control of the train are represented by the pulse pattern in the table below.

Instruction to motor control	*Pulse pattern*
Start train	
Travel at constant speed	
Stop train	

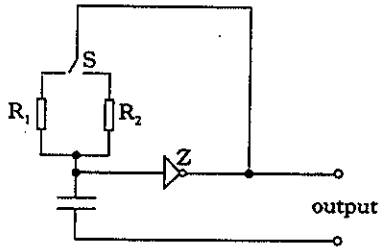
(*a*) State the frequency of the pulses used to start the train.

4 Hz (1)

..... (1)

(*b*) The pulses are produced by the pulse generator shown in figure 1. The supply voltage is not shown.

figure 1



(i) Name component Z.

NOT gate or inverter (1)

..... (1)

(ii) Switch S makes a connection with resistor R_1 to start the train and with resistor R_2 to run the train at constant speed.
Which of the resistors has the lower resistance? Give a reason for your answer.

R_2 since the lower the value of resistance the higher the frequency of the pulses (1) or equivalent

..... (2)

NOTES

4 Pulses per second ok.

R_1 + explanation — zero marks

R_1 — zero marks

Mark separately otherwise

Question No. 10(a)/(b)

K&U PS

Marks

10. (continued)

(c) The train cannot start until its doors are closed. An electronic circuit is used to give an output which shows whether a door of the train is open or closed.

The circuit gives an output of +5 V (logic 1) when the door is closed and an output of 0 V (logic 0) when the door is open. Two circuits P and Q are shown in figure 2. Switch S is closed when the train door is closed.

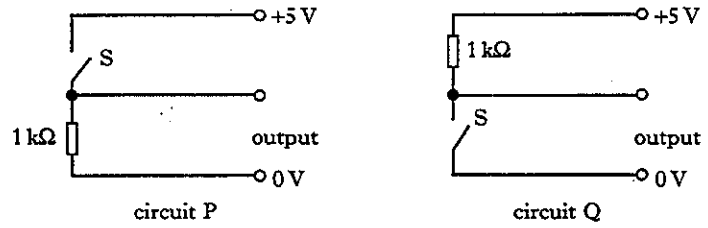


figure 2

State which of the circuits P or Q is used and give a reason for your answer.

Circuit P since ① — circuit Q — zero either with S closed (voltage across 1kΩ) is 5V ①
or " " open " " " is 0V ① (2)
(output voltage)

[Turn over

or with switch closed voltage across switch is 0V
" " open " " " is 5V ①

or why Q would not work

NOTES

Accept
5V - logic 1 - High as alternatives
or 0V - logic 0 - low "

Question No. 10(c)

K&U PS

Marks

11. A roller coaster is designed with a vertical drop as shown below. A vehicle is moved from P to the top of a slope at Q. At the top of the slope the vehicle is released and it falls vertically from R to S.

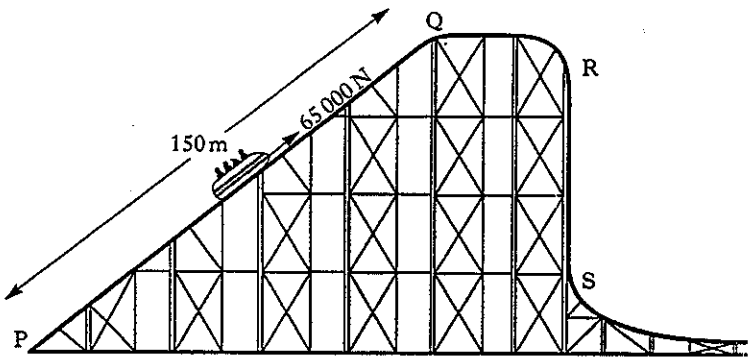


figure 1

(*a*) A force of 65 000 N is applied over a distance of 150 m to move the vehicle at a constant speed from P to Q.

How much work is done by the force in moving the vehicle?

Space for working and answer

$E_w = F.d$ (½)

$= 65000 \times 150$ (½)

$= 9,750,000\ J\ (9.75 \times 10^6\ J)$ (1)

(2)

(*b*) The vehicle and passengers reach a maximum height of 110 m. The total mass of vehicle and passengers is 8500 kg.

Calculate the potential energy gained by the vehicle and passengers.

Space for working and answer

$E_p = mgh.$ (½)

$= 8500 \times 10 \times 110$ (½)

$= 9\,350\,000\ J\ (9.35 \times 10^6\ J)$ (1)

(2)

NOTES

Accept other values for g

Question No. 11(a)(b)

K&U	PS

11. cont.

(c) The technician should not be exposed to a dose equivalent of more than 10mSv each year. What factors will effect the dose equivalent she receives?

. . . . . .

. . . . . .

. . . . . .

. 2

12. During a game A player injures a knee. An X-ray is taken to check whether a bone has been broken, and ultrasound is used to determine if any fluid has formed in the knee. Figure 1 shows the position of the X-ray transmitter, and figure 2 the position of the ultrasound transmitter and receiver in front of the knee.

(a) Indicate where on figure 1 the receiver for the X-rays should be placed 1

(b) Explain why the ultrasound transmitter and receiver are on the same side of the knee as shown in figure 2.

. . . . . .

. . . . . .

. . . . . .

. 2

(c) The ultrasonic waves have a frequency of 8.0Mhz. Calculate the wavelength of the ultrasound in bone.
(Data you require will be found in the data sheet on page two.)

Space for working and answer

3

turn over

11. (continued)

Marks

(c) The vehicle is designed to travel at 5 m/s at R and to travel vertically for 4 s to S. A pupil draws a speed–time graph of the motion between R and S as shown in figure 2.

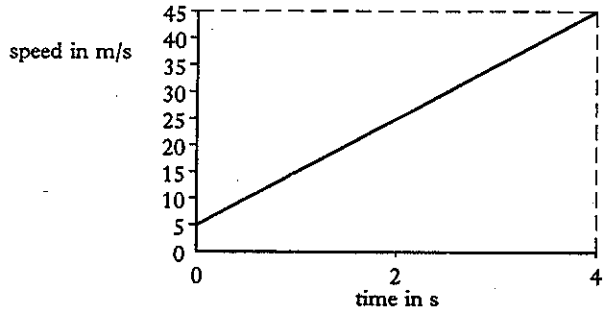


figure 2

Calculate the value the pupil's speed-time graph predicts for the length of the vertical drop from R to S.

Space for working and answer

Length of drop = area under graph (½)
= (½ × 40 × 4) + (5 × 4) (½) [or ½ × 50 × 4]
= 80 + 20 [100]
= 100m (1)

(2)

(d) In drawing the speed-time graph, the pupil has assumed that the acceleration of the vehicle is 10 m/s².

Explain whether the actual value for the vertical drop would be greater or less than the value predicted from the pupil's speed-time graph.

Vertical drop would be less (1) since acceleration would be less (than 10 m/s²) (½) due to frictional forces (½) (2)

(e) Describe how the speed of the vehicle at S could be measured.

Set up light gate (at S) connected to (timer or computer) (1)
Measure length of vehicle (½)
~~Time to cut light gate is noted~~ (½)
speed = length of vehicle / time to cut light gate (½) (2)

QE ▽ ITSA, Vela

NOTES

Alternative using average speed

$d(\text{length}) = \bar{v}\,t = \frac{45+5}{2} \times 4 = 25 \times 4 = 100\text{m}$

($\frac{1}{2}$) ($\frac{1}{2}$) (1)

If one area ~~not~~ omitted then ½ for formula only

If arithmetic slip in 1 area then −½

$d = vt$ ie no average − 0

or vertical drop would be less (1) since acceleration would be less ($\frac{1}{2}$) because $g = 9.8\text{ m/s}^2$ ($\frac{1}{2}$)

or vertical drop would be less (1) since final speed would be less ($\frac{1}{2}$) due to (frictional) force ($\frac{1}{2}$)

If say acceleration less then still gets ½ mark.

Question No. 11 (c)/(d)/(e)

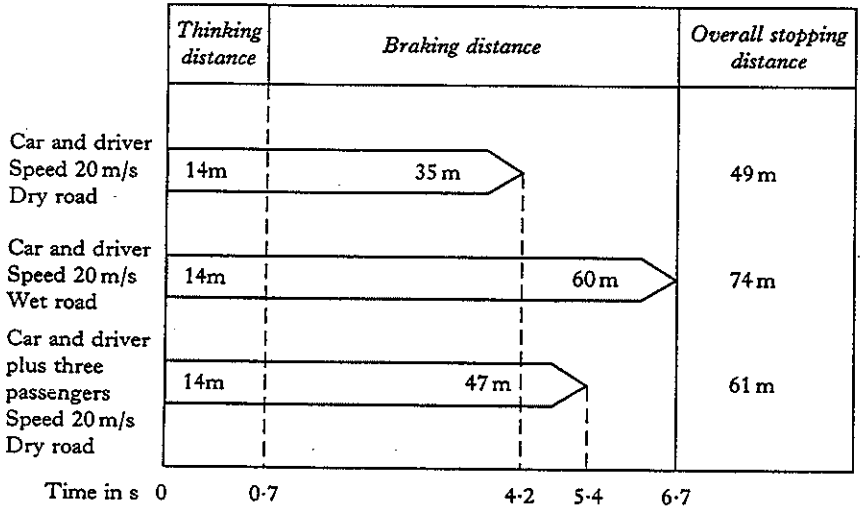
Marks

12. The highway code requires drivers to know about the overa opping distance for vehicles. The overall stopping distance is made up of:

(1) the **thinking distance**—the distance travelled while the driver "thinks" about braking;

(2) the **braking distance**—the distance travelled while braking.

The following diagram gives information about the overall stopping distance of a car and the time for the car to come to rest under different conditions. Timing starts from the moment the driver recognises there is a need to brake and stops when the car comes to a halt.



(*a*) Explain why the thinking distance is the same for the different conditions.

Reaction time is same (1) and speed is same (½) and distance = speed x time (½) (2)

(*b*) Calculate the deceleration of the car on the wet road.

Space for working and answer

$a = \frac{v-u}{t}$ (½) Accept $\frac{20-0}{6}$ as deceleration

$= \frac{0-20}{6}$ (½)

$= (-)3{,}3\ m/s^2$ (1) (2)

[3220/102]

20

NOTES

time for brain to process information OK
must imply reaction time

if time given as 6·7s then ½ only

Question No. 12 (a)/(b)

12. **(continued)** *Marks*

(c) The total mass of the car and driver is 1500 kg.
Calculate the unbalanced force on the car while braking on the wet road.

Space for working and answer

$F = ma$ (A)

$= 1500 \times 3.3$ (½)

$= 4950\,N\ (5000\,N)$ (1)

[$= 4995\,N$, if $a = 3.33\,m/s^2$]

(2)

(d) Explain why the stopping distance on a dry road increases when the car has passengers.

$F = ma$, so (½) or Force is constant (½)

with greater mass (momentum) (with passengers) (½)

deceleration is reduced (1) or less acceleration (½)

If weight used rather than mass then deduct ½ (max 1½)

more { kinetic energy / momentum / mass / inertia } - ½ force is const. - ½

greater E_k ½ ⇒ more work done (1)

[Turn over

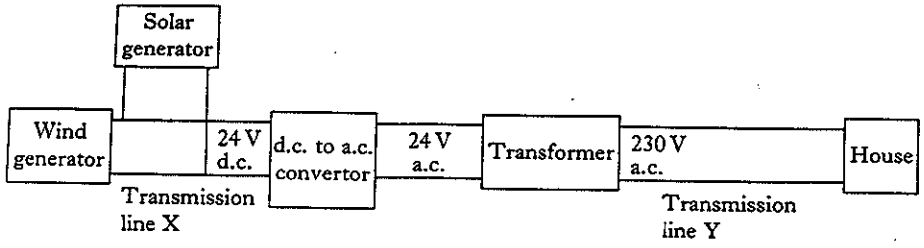
NOTES

dotted line

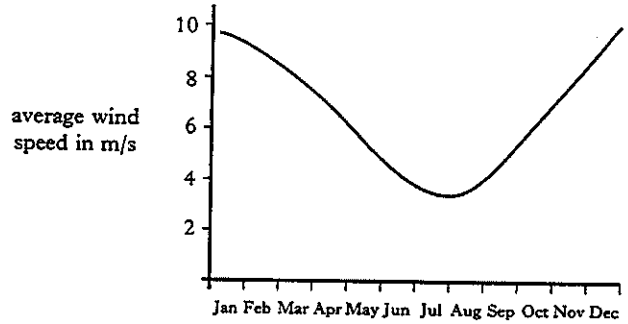
Ignore – sign if

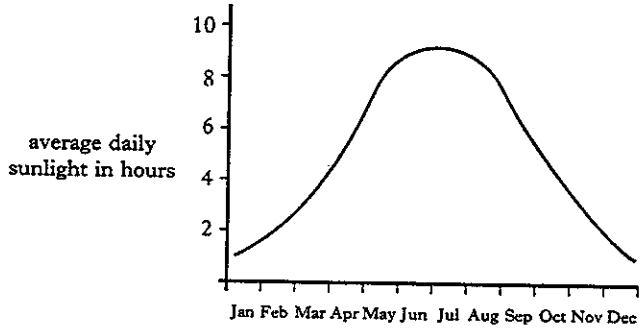
Marks

13. Electrical power may be provided to remote homes by a combina of wind and solar generators as shown in the diagram below.



(a) The following graphs show how the average wind speed and average daily sunlight vary over a year.





Explain why the combination of wind and solar generators provides an effective system.

(In Winter) greater ave. wind speed makes wind generator effective (1)

(In Summer) greater ave daily sunlight makes solar generator effective (1) (2)

[3220/102]

NOTES

When wind speed less than there is more sunlight

When its sunny its not windy (1)

When its windy its not sunny (1)

1 for something else.

use professional judgement

Question No. 13(a)

13. (continued)

Marks

(*b*) The output voltage from the solar and wind generators is 24 V d.c.

Explain the need for the d.c. to a.c. convertor between the generators and the transformer.

Transformers work on a.c. (1)

OR Transformers do NOT work with d.c. (1)

(*c*) The transformer steps up the voltage from 24 V to 230 V. There are 480 turns on the primary coil of the transformer.

Calculate the number of turns on the secondary coil.

Space for working and answer

$\frac{V_S}{V_P} = \frac{N_S}{N_P}$ (1/2)

$\frac{230}{24} = \frac{N_S}{480}$ (1/2)

$N_S = \frac{230 \times 480}{24} = 4600.$ (1)

(2)

(*d*) The electrical power loss is less in transmission line Y than in transmission line X although the resistance of line Y is greater.

Explain.

Less current in line Y (1)

Transformer steps down

and power loss is given by I^2R (1)

(so less current gives less power loss) (2)

[Turn over

NOTES

14. **(continued)**

Marks

(*b*) The booster rockets are parachuted to Earth before *Discovery* enters orbit around the Earth. In orbit, *Discovery's* rocket engines are switched off. Figure 2 shows *Discovery* in orbit around the Earth.

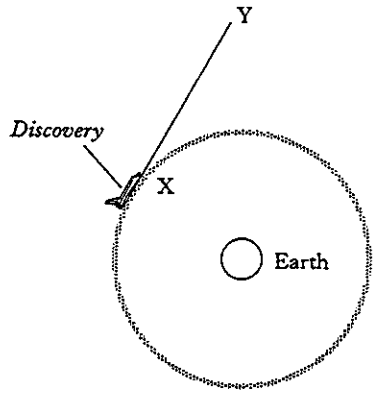


figure 2

Explain why *Discovery* remains in orbit and does not:

(i) move closer to the Earth.

~~Speed enough~~ Satellite has ~~a~~ horizontal ~~speed~~ or Satellite has forward motion (1) or Satellite has motion at right angles to force of gravity

(ii) move off into space along XY.

There is a force (of gravity) towards the centre of the Earth (1)

(2)

Weight or Pull of gravity / or grady pulling gravity acting towards the earth or constantly falling towards the earth or Horizontal speed too low

NOTES

or as satellite falls to earth, the earths surface ~~falls~~ curves away

large enough speed - ~~of~~ enough is necessary

because of gravity alone - 0

~~gravity alone~~

Marks

15. (*a*) In 1971, a lunar module carrying two astronauts landed o[illegible]e Moon's surface. The gravitational field strength on the Moon is different from that on Earth.

(i) What is meant by "gravitational field strength"?

{Force (of gravity)} per unit mass (or on each kg)
{Weight} ①

..... (1)

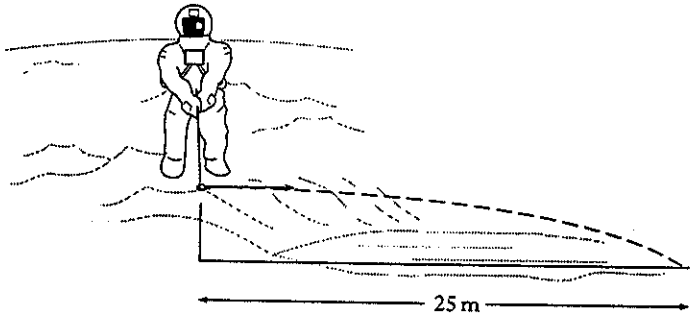
(ii) The gravitational field strength at the surface of the Moon is 1·6 N/kg.

What is the value of the acceleration due to gravity at the surface of the Moon?

1.6 m/s² ① or N/kg

..... (1)

(*b*) One of the astronauts played golf on the moon. The golf ball was struck horizontally from the edge of a steep crater. It landed 2 seconds later, 25 m away as shown in the diagram below.



(i) Calculate the horizontal speed of the ball after being struck.

Space for working and answer

$v = \frac{d}{t}$ ½

$= \frac{25}{2}$ ½

$= 12.5$ m/s ①

(2)

NOTES

Not Newtons per kg

no unit ~~-1mk~~ deduct ½

15. (*b*) (continued)

Marks

(ii) Calculate the vertical speed of the ball on landing.

Space for working and answer

$a = \frac{v-u}{t}$ (½)

$1.6 = \frac{v-0}{2}$ (½)

$v = 2 \times 1.6 = 3.2 \text{ m/s}$ (1)

(2)

(iii) How would the horizontal distance travelled by a ball projected with the same horizontal speed from the same height on Earth compare with that on the Moon?

Explain your answer.

Distance would be less since (1)

EITHER { greater field strength (or acceleration due to gravity) (1)
means time to fall is decreased (1)

OR { Friction due to Earth's atmosphere (1)
cause a horizontal deceleration (1) } (3)

[*END OF QUESTION PAPER*]

NOTES

Can argue distance would be more on the moon + explanation

of greater pull of the earth

Hits ground quicker – Do not accept as could employ velocity