SUPPLEMENT

TO THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL

Vol. 71 Part 4 **January 1979**

ISSN 0309-2720

TEC, SCOTEC & CGLI: GUIDANCE FOR STUDENTS

Contents

TECHNICIAN EDUCATION COUNCIL

Certificate Programme in Telecommunications

Sets of model questions and answers for level-1 TEC units are given below. They have been designed following analysis of assessment test papers actually set during the 1977–78 session by a number of colleges all over the country. The model questions and answers reflect the types and standard of question set and answer expected, and include the styles of both in-course and end-of-unit assessments.

The model questions and answers therefore illustrate the assessment procedures that students will encounter, and are useful as practice material for the skills learned during the course.

The use of calculators is permitted except where otherwise indicated.

Representative time limits or proportion of marks are shown for each question (or group of questions), and care has been taken to give model answers that reflect these limits. Where additional text is given for educational purposes, it is shown within square brackets [ ] to distinguish it from the information expected of students under examination conditions.

We would like to emphasize that, because the model questions are based on work at a number of colleges, they are not representative of questions set by any particular college.

As a general rule, questions are given in italic type and answers in upright type. Answers are sometimes shown in bold upright type; this is because, for objective questions, it is convenient to place the questions and answers side by side, and bold type enhances the distinction in such cases. Where possible, answers have been positioned such that they may be covered up if desired.

(We would like to advise CGLI students that they may find our TEC coverage useful as additional practice material. Coverage of the 1978 CGLI examinations will commence in the April 1979 issue of the *Supplement*.)

TELECOMMUNICATION SYSTEMS 1 1977–78

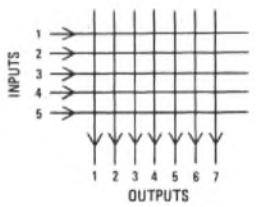
Q1 (*a*) *Draw a simple diagram of a simple switch capable of connecting any one in a group of 5 input circuits to any one in a group of 7 output circuits.*

(*b*) *What sort of switch is this?*

(*c*) *How many crosspoints has the switch?*

(*d*) *How many crosspoints can be simultaneously operated if no double connexions are to occur?* (*4 min*)

A1 (*a*)



(*b*) A matrix switch

(*c*) 35

(*d*) 5

Q2 *State the possible numerals with which a telephone number could begin in a step-by-step telephone exchange, and explain the uses of the other numerals.* (*3 min*)

A2 The numerals that can be used are 2, 3, 4, 5, 6 and 7. Telephone numbers do not begin with 0, 1, 8 or 9 because

(*i*) level 0 is used for access to the STD and ISD networks,

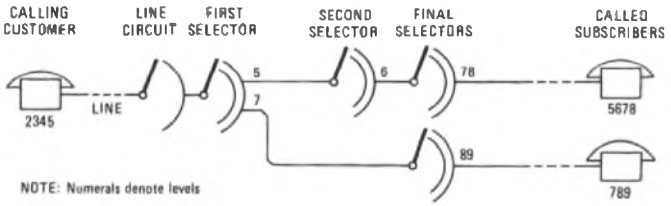
(*ii*) level 1 is used for access to the operator services, and to cricket and "dial-a-disc" services,

(*iii*) level 8 is used to route calls to adjacent exchanges, and for access to the other information services, and

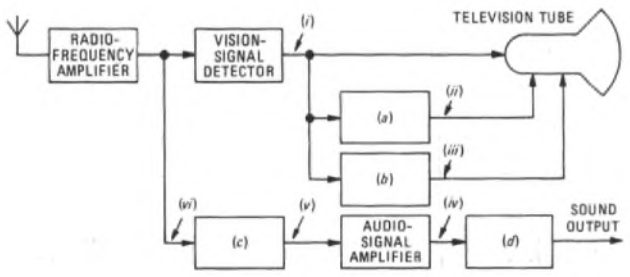
(*iv*) level 9 is used for access to the emergency services, and for routing calls to other adjacent local exchanges.

Q3 *Draw a simple trunking diagram to show how telephone customer 2345 would be connected to customer 5678 through a step-by-step telephone exchange. Extend the trunking diagram to show how the same customer (2345) would be connected to customer 789.* (*8 min*)

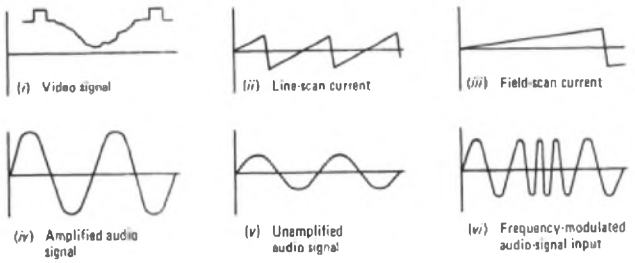
A3



Q4 *The block diagram represents a television receiver. Four of the blocks have been labelled only by the italic letters* (*a*) *to* (*d*). *In each case, indicate the block's correct title. Show typical waveforms* (*against time*) *that can be expected at the points indicated by the Roman numerals* (*i*) *to* (*vi*). (*4 min*)

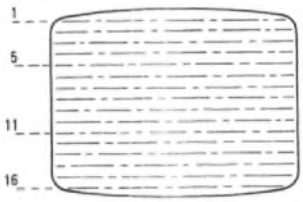


A4 (*a*) Line-scan control (*b*) Field-scan control
(*c*) Audio-signal detector (*d*) Loudspeaker



Q5 The sketch shows a typical television screen. On the screen is an example of an interlaced scan.

(*a*) *By measurement, determine the aspect ratio.*
(*b*) *State the number of interlaced lines.*
(*c*) *State the number of lines per frame.*
(*d*) *State the number of lines per field.*
(*e*) *State the order in which the lines would be scanned to assemble the picture.*
(*f*) *Is it true or false that the main reason for interlaced scanning is to improve the quality of the picture?* (*3 min*)



A5 (*a*) Aspect ratio
= 33 mm/24·75 mm,
= 1·33 = 4:3.
(*b*) 16 (*c*) 16 (*d*) 8
(*e*) 1, 3, 5, 7, 9, 11, 13, 15, 2, 4, 6, 8, 10, 12, 14, 16
(*f*) False

Q6 For each of the following, state the type of computer that could be used. (*1 min*)

(*a*) *Missile flight simulation.*	**Analogue**
(*b*) *Wage payments.*	**Digital**
(*c*) *Flight simulator.*	**Analogue**
(*d*) *Bank accounts.*	**Digital**
(*e*) *Personnel statistics.*	**Digital**
(*f*) *Production line.*	**Digital**
(*g*) *Library index.*	**Digital**

Q7 What is the name of the unit used to connect a Post Office line to a computer terminal, and from what words is the name derived? (*1 min*)

A7 Modem, a contraction of *mo*dulator and *dem*odulator.

Q8 State 2 advantages and 2 disadvantages of using computers. (*1 min*)

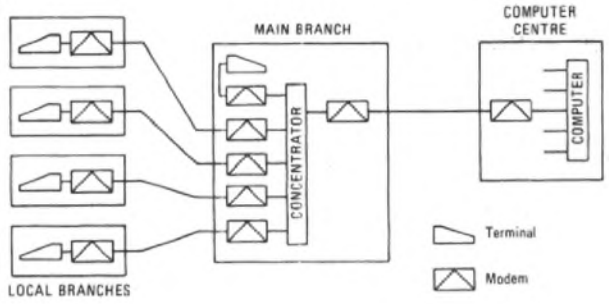
A8 Advantages: (*a*) large quantities of information can be stored, and
(*b*) complicated mathematics can be performed quickly.
Disadvantages: (*a*) trained operators are required, and
(*b*) installation and maintenance are expensive.

Q9 Explain the difference between hardware and software. (*2 min*)

A9 Hardware is the term used to describe the manufactured equipment that is needed to build a computer (such as the circuit boards). Software is the term used to describe the information needed to make the hardware work (such as the program).

Q10 Show, by means of a simple block diagram, how a local network of 4 banks is connected to a computer centre via a main branch. (*5 min*)

A10



Q11 Why are amplifiers needed on long-distance circuits, and why are they needed in both directions of transmission? Why are several amplifiers needed in each direction of transmission? (*10 min*)

A11 Amplifiers are needed on long-distance circuits because transmission lines attenuate signals transmitted along them. Unamplified, these signals would eventually become indistinguishable from line noise, which increases in strength as the line length increases.

It is necessary to amplify each direction of transmission because amplifiers are basically unidirectional devices; the design of amplifiers capable of simultaneously amplifying two directions of transmission requires the line to be critically set up to avoid instability.

Several amplifiers are needed for two reasons. Firstly, to use one high-gain amplifier at the transmission point of the circuit to keep the signal strength to a level desirably above the noise level for the whole length of the circuit would mean that the transmitted level would be excessive. This would cause crosstalk between this circuit and other circuits.

Secondly, the use of one high-gain amplifier at the receiving end, capable of compensating for all the attenuation caused by the line, would mean that the relatively high noise level mentioned above would also be amplified, and the signal would still be indistinguishable from the noise.

Q12 At what point in setting-up a telephone call may the following signals be heard by the caller: (a) number-unobtainable tone, (b) ringing tone, (c) dial tone, and (d) equipment-engaged tone? (*5 min*)

A12 (*a*) At any time a digit is dialled that constitutes a code not available.

(*b*) On successful connexion to the called customer's line, while waiting for the called customer to answer.

(*c*) After lifting the handset, and on seizure of equipment capable of accepting digits (such as a first selector in a Strowger exchange, or a register in a TXK1 exchange).

(*d*) At any stage where use is demanded of equipment already fully engaged; that is, equipment fully occupied with processing other calls and having no spare capacity to deal with the current call.

Q13 What are the types of exchange that are fully interconnected in the following networks? (*1 min*)

(*a*) *Telegraph network*	**Zone centres**
(*b*) *Telephone network*	**Main switching centres**

Q14 In what part of the telephone network are coaxial cables used? (*2 min*)

A14 For economic transmission over long-distance routes. Signals for each circuit modulate a different carrier frequency and the carriers are then combined onto a single coaxial cable, which is a more efficient means of transmitting high frequencies than are pair-type conductors.

Q15 Draw a simple block diagram illustrating how a customer is connected to a telephone exchange via a distribution point, a primary cross-connexion point and a secondary cross-connexion point. (*3 min*)

A15

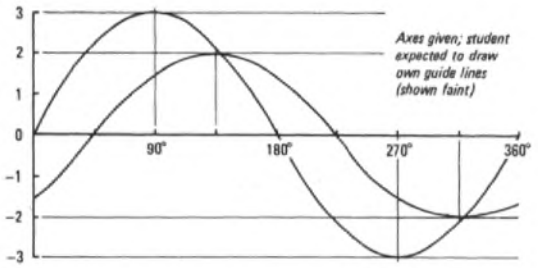
Q16 A radio transmitter operates at 98 MHz. (a) State the velocity of propagation of the radio waves through the atmosphere, (b) calculate the wavelength, and (c) calculate the periodic time. (*4 min*)

A16 (*a*) 3×10^8 m/s.

(*b*) Wavelength $= \dfrac{\text{velocity (m/s)}}{\text{frequency (Hz)}} = \dfrac{3 \times 10^8}{98 \times 10^6} = 3{\cdot}06$ m.

(*c*) Periodic time $= \dfrac{1}{\text{frequency (Hz)}} = \dfrac{10^{-6}}{98}$ s $= 10{\cdot}2$ ns.

Q17 Sketch (on the axes below) two sine waves, one with an amplitude of 3, and the other with an amplitude of 2 but lagging the first by 45°. (*5 min*)



Q18 Why is modulation used on long-distance circuits? (*4 min*)

A18 Modulation is used on long-distance circuits (usually with a carrier spacing of 4 kHz) so that many circuits can be carried simultaneously on one coaxial cable. This gives economies in the amount of cable needed and, consequently, in the number of amplifiers and line-conditioning equipments needed. Also, modulated high-frequency carriers are more suitable for propagation over long distances than are audio frequencies.

Q19 What is the output frequency band of an amplitude modulator having a speech-band input and a carrier frequency of 72 kHz? (*2 min*)

A19 [The commercial speech band is 300–3400 Hz. The output of an amplitude modulator is the carrier frequency ± the modulating signal, the output bandwidth being the carrier frequency ± the maximum modulating frequency.]

The output frequency band

$= 72\,000 - 3400$ to $72\,000 + 3400$ Hz,

$= 68{\cdot}6$–$75{\cdot}4$ kHz.

Q20 Which of the following statements are true? (*2 min*)

(*a*) *The output of a frequency modulator has a constant amplitude.* **True**

(*b*) *The carrier spacing on British Post Office channels is always 3 kHz.*

(*c*) *There is no output from an amplitude modulator when there is no modulating input.*

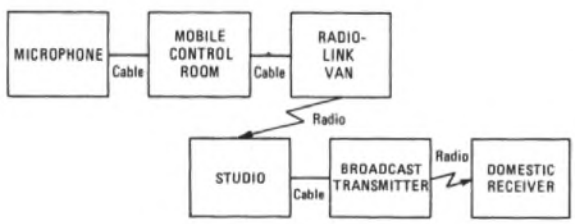
(*d*) *There is no output from a frequency modulator when there is no modulating input.*

(*e*) *The carrier frequency of a demodulator must be identical with the unmodulated carrier.* **True**

(*f*) *The output of a frequency modulator has a constant frequency.*

Q21 Draw a block diagram of a BBC radio outside-broadcast link, showing the medium between each block, the studio, the receiver (microphone), a mobile control room, a radio-link van, the broadcast transmitter, and a domestic receiver. (*8 min*)

A21



Q22 Why is it necessary to have two different carriers for a 2-way radio telephone link? (*4 min*)

A22 Different carriers are required for each direction of transmission. This is because each receiver must be able to distinguish between the transmitted signal and the received signal. Each receiver must be able to detect and amplify only its respective received signal, and to filter out the local transmitted signal.

Q23 What sort of signals follow the curvature of the earth? (*1 min*)

A23 Ground waves: very-low frequencies (below 30 kHz).

Q24 What is the most important consideration when deciding the position of the aerials in a microwave-radio system? Explain why it is so important. (*2 min*)

A24 The aerials must be in line of sight with each other because microwaves travel in straight lines and do not follow the curvature of the earth.

Q25 State 2 types of navigation system used for shipping. (*1 min*)

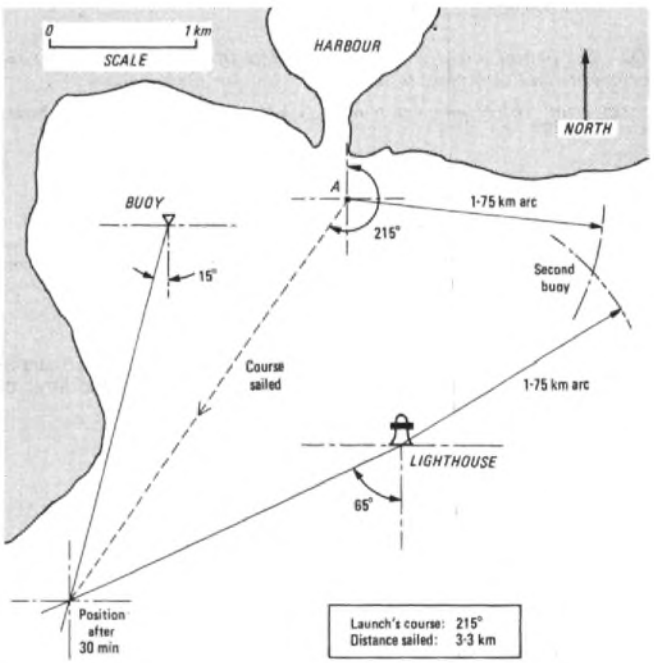
A25 (*i*) DECCA (*ii*) LORAN

Q26 The map shows a launch leaving harbour, together with the surrounding coastline, a buoy and a lighthouse. Thirty minutes after leaving point A, the launch takes the following radar readings, using a plan-position indicator:

lighthouse: 65° relative to north; buoy: 15° relative to north.

Show on the map the course sailed from point A. State the launch's course relative to north. How far has it travelled from point A?

A second buoy is located 1·75 km from the lighthouse and point A and on the east-side of the lighthouse. Show its position on the map. (*15 min*)



Q27 By reference to the map in Q26 above, state which of the displays illustrated below represents that of the launch's plan-position indicator as it leaves point A. (*1 min*)

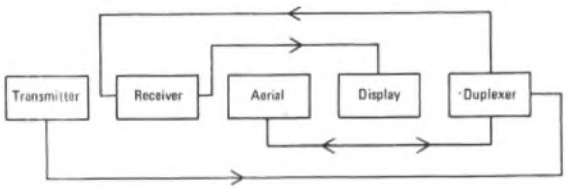
(*a*) (*b*) (*c*) **Answer: (c)**

Q28 The following blocks are the elements of a primary radar system.

Transmitter	*Receiver*	*Aerial*	*Display*	*Duplexer*

Connect the blocks together in the correct sequence. (*2 min*)

A28



Q29 Give a simple explanation of the system whose block diagram is shown in Q28. (*10 min*)

A29 The transmitter produces pulses of radio waves (in the band 150–30 000 MHz) at high power. About 1000 pulses are transmitted each second, each pulse having a duration of about 1 μs. The duplexer switches the system between the transmitting and receiving modes.

The system works on the principle of measuring the time taken for a pulse to travel from the aerial to the reflector and back to the receiver. The OFF time of the transmitter thus determines the range of the system, because a reflected pulse must arrive before the next pulse is transmitted; the longer the pause between pulses, the greater the range.

The display is basically an oscilloscope. The sweep of the display is controlled such that it begins as a transmitted pulse ceases, and full deflexion is reached as the next transmission is due to start. Since radio waves travel at a known velocity, it is possible to relate the reflection time to distance (allowing for the fact that the pulses travel twice the distance between the aerial and the reflector). The scale on the display is therefore graduated directly in terms of distance, allowing direct reading.

Q30 What is the main difference between primary and secondary radar? (*2 min*)

A30 Primary radar transmits its own signals, and receives reflections of these. Secondary radar relies on signals transmitted from a remote source.

PHYSICAL SCIENCE 1 1977–78

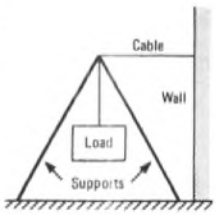
This set of model questions and answers illustrates the assessment procedures that students encounter in this unit, and includes the styles of both in-course and end-of-unit tests. It is not representative of the questions set by any particular college.

The model answers illustrate what is expected of students in the time allowed. Where additional text is given for educational purposes, and does not form part of the answer, it is shown in square brackets.

Questions are given in italic type and answers in upright type. Answers to objective questions are given in bold upright type for clarity. Where possible, answers are positioned such that students may cover them.

TYPICAL TIME LIMIT FOR Q1–4: 7 min

Q1



A load is suspended from a system of supports by a cable fixed to a wall, as shown in the sketch. State the type of stress experienced by:

(*a*) *the wall*	**Shear**
(*b*) *the cable*	**Tensile**
(*c*) *the supports*	**Compressive**

Q2 The unit of stress is the pascal. Select from the following list the composite unit equivalent to the pascal.

(*a*) *N/m* (*b*) *N/m²* (*c*) *N m* (*d*) *kN/m* **N/m²**

Q3 A metal rod obeys Hooke's law, and is extended by 1·2 mm when subjected to a tensile force of 10 N. If the elastic limit has not been exceeded, what force is required to give an extension of 1·5 mm, and what will be the extension if the force is reduced to 8 N?

A3 [Hooke's law states that the strain produced in an elastic material is directly proportional to the applied stress, provided the limit of proportionality is not exceeded.]

The force required to give an extension of 1·5 mm

$$= 10 \times 1{\cdot}5/1{\cdot}2 = \underline{12{\cdot}5\ \text{N}}.$$

The extension produced by a force of 8 N

$$= 1{\cdot}2 \times 8/10 = \underline{0{\cdot}96\ \text{mm}}.$$

Q4 Select from the following list the correct expression for Young's modulus of elasticity.

(*a*) $\frac{force}{extension}$ (*b*) $\frac{extension}{force}$

(*c*) $\frac{stress}{strain}$ (*d*) $\frac{strain}{stress}$ **Stress / Strain**

TYPICAL TIME LIMIT FOR Q5–10: 8 min

Q5 Calculate the work done when a force of 50 N moves a trolley through a distance of 50 m. Express your answer (a) in terms of force and distance, and (b) in joules.

A5 (*a*) Work done = force × distance = 2500 N m. = $\underline{2{\cdot}5\ \text{kN m}}$.

(*b*) Since 1 N m = 1 J, the work done = 2500 J = $\underline{2{\cdot}5\ \text{kJ}}$.

Q6 A machine has an efficiency of 75%. What energy input is required to produce an output of 1200 J? If the machine produces an output of 1200 J every 5 s, what is the machine's output power?

A6 Energy input = 1200 × 100/75 = 1600 J = $\underline{1{\cdot}6\ \text{kJ}}$.

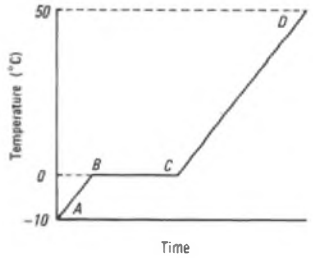
Output power = 1200/5 J/5 = $\underline{240\ \text{W}}$.

Q7 Comparing the filament of a 100 W light bulb (when lit) with a domestic hot-water tank full of hot water, select the correct pair of statements from the table below.

Pair	*Filament*	*Hot Water*
(*a*)	*Higher temperature*	*Less heat*
(*b*)	*Less heat*	*Higher temperature*
(*c*)	*Higher temperature*	*More heat*
(*d*)	*More heat*	*Higher temperature*

Pair (c)

Q8 The sketch shows the changes of temperature which take place when a constant supply of heat energy is used to melt a block of ice and then raise the temperature of the water to 50°C. State whether the sections AB, BC and CD of the graph represent latent or sensible heat.



A8 AB: sensible heat
BC: latent heat
CD: sensible heat

Q9 Complete the following statements.

(a) The transfer of heat from one end of a solid metal bar to the other is by ..... **conduction**
(b) The transfer of heat in a gas or liquid by the movement of cooler denser gas or liquid replacing warmer less-dense gas or liquid near to the source of heat is known as ..... **convection**
(c) The transfer of heat from one body to another without the need of an intervening medium is called ..... **radiation**

Q10 Calculate the energy required to raise the temperature of 200 kg of water from 20°C to 40°C. The specific heat capacity of water is 4180 J/kg °C.

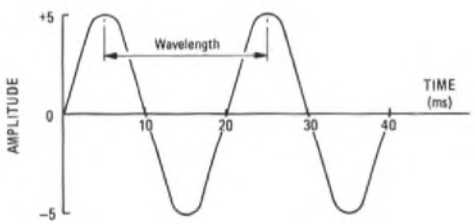
A10 [The energy required (joules) is given by the mass of water (kilograms) multiplied by the specific heat capacity (joules/kilogram degree Celsius) and the temperature rise (degrees Celsius).]

$$\therefore \text{ energy} = 200 \times 4180 \times 20 \text{ J} = \underline{16{\cdot}72 \text{ MJ}}.$$

TYPICAL TIME LIMIT FOR Q11: 10 min

Q11 (a) Using a suitably scaled axis, sketch 2 cycles of a wave having a frequency of 50 Hz and an amplitude of 5 units.
(b) With reference to your sketch, explain the term wavelength.
(c) A wave has a velocity of propagation of 1000 m/s in a given medium. Calculate its frequency if it has a wavelength of 10 mm.

A11 (*a*)



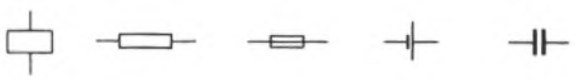
(*b*) The wavelength is the distance between 2 identical points on successive cycles of the wave, such as between 2 successive maximum points as shown on the sketch.

(*c*) Frequency = velocity/wavelength,

$$= 1000/10 \times 10^{-3} \text{ Hz} = \underline{100 \text{ kHz}}.$$

TYPICAL TIME LIMIT FOR Q12–20: 15 min

Q12 Identify the following components.

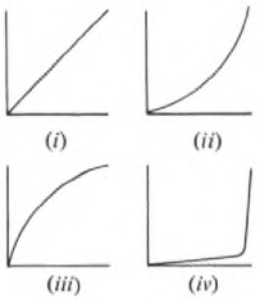


Relay **Resistor** **Fuse** **Cell** **Capacitor**

Q13 Complete the following statements

(a) The unit of electric current is the ..... **ampere**
(b) The unit of potential difference is the ..... **volt**
(c) The unit of electrical resistance is the ..... **ohm**
(d) These units are related by the formula:
current in **amperes = volts/ohms**

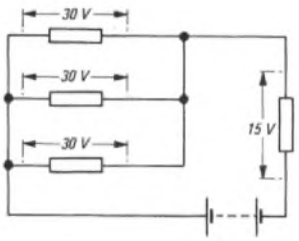
Q14



The horizontal axis of each graph represents voltage, and the vertical axis represents current. Identify the graph that illustrates obedience to Ohm's law.

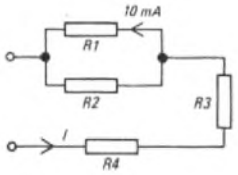
Graph (i)

Q15 Select from the list the voltage of the battery in the circuit shown.



(a) 105 V
(b) 25 V
(c) 45 V **45 V**
(d) 15 V

Q16 Resistors R1, R2, R3 and R4 are all equal, and a current of 10 mA flows in R1. Select the correct value of current (I) flowing into the circuit.



(a) 40 mA
(b) 20 mA **20 mA**
(c) 30 mA
(d) 25 mA

Q17 If the resistance of a uniform copper busbar must not exceed 0·02 Ω, and its length is 25 m, what is its cross-sectional area? The resistivity of copper is 1·7 × 10⁻⁸ Ω m.

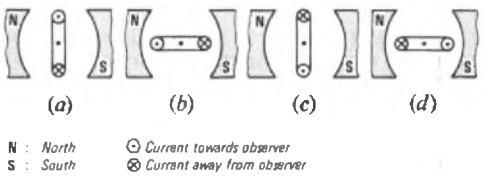
A17 [The resistance, R ohms, of a uniform conductor at a given temperature is given by $R = \rho l/a$, where ρ is the resistivity of the material (ohm metres), l is the length of the conductor (metres), and a is its cross-sectional area (metres²).]

$$\therefore a = 1{\cdot}7 \times 10^{-8} \times 25/0{\cdot}02 \text{ m}^2 = \underline{21{\cdot}25 \text{ mm}^2}.$$

Q18 The 3 main effects of an electric current are magnetic, chemical and heating. State the effect present in each of the following.

(a) Corrosion in lead sheath of cable **Chemical**
(b) Operation of telephone receiver **Magnetic**
(c) Operation of fuse **Heating**
(d) Lighting of filament lamp **Heating**

Q19 The sketches show the coil of a moving-coil meter in 2 vertical and 2 horizontal positions. In which sketch will the coil move in a clockwise direction?



N : North ⊙ Current towards observer
S : South ⊗ Current away from observer

Sketch (b)

Q20 (a) Write down a formula relating power (P), voltage (V) and current (I), stating the appropriate SI units. (b) Write down an alternative formula for power which can be used when only the current and resistance (R) are known.

A20 (*a*) P watts = V volts × I amperes (*b*) $P = I^2R$

TYPICAL TIME LIMIT FOR Q21–24: 35 min

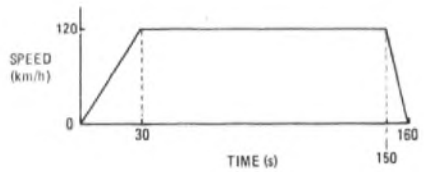
Q21 State the difference between speed and velocity, and give one example of each.

A21 Speed is the rate of change of position of a body without regard to its direction of motion. A car travelling in an unspecified direction may be said to have a *speed* of 50 km/h.

Velocity is the rate of change of position of a body in a specified direction. A car travelling in a known direction may be correctly said to have a *velocity* of 50 km/h *due south*.

Q22 A motor cyclist, starting from rest, reaches a speed of 120 km/h in 30 s with constant acceleration. He maintains this speed for 2 min, and then comes to rest in a further 10 s with constant deceleration. Plot a graph of speed/time for the total period, and calculate (a) the acceleration during the first 30 s, and (b) the total distance travelled.

A22



(*a*) Acceleration = (change in speed)/(time taken),

$$= (120 - 0) \times 1000/30 \times 3600 = \underline{1{\cdot}11 \text{ m/s}^2}.$$

(*b*) Distance travelled = average speed × time,
and average speed = ½ (final speed + initial speed),
assuming a constant rate of change.

During the first 30 s, the average speed is 60 km/h, and the distance travelled is $60 \times 1000 \times 30/3600 = 500$ m.

During the next 2 min, the distance travelled is $120 \times 1000 \times 2/60 = 4000$ m.

During the final 10 s, the average speed is 60 km/h, and the distance travelled is $60 \times 1000 \times 10/3600 = 166{\cdot}7$ m.

$$\therefore \text{ total distance} = \underline{4{\cdot}67 \text{ km}}.$$

Q23 A hoist, at a floor halfway up the hoist shaft, is loaded with goods having a total mass of 50 kg. If the hoist motor applies a lifting force of 250 N when the brake is removed, in which direction will the hoist accelerate? Calculate that acceleration. (The acceleration due to gravity is 9·81 m/s².)

A23 [Force (newtons) = mass (kilograms) × acceleration (metres/second²).]

The force acting on the loaded hoist due to gravity

$$= 50 \times 9{\cdot}81 = 490{\cdot}5 \text{ N}.$$

Since the motor applies a lifting force of only 250 N, the hoist accelerates downwards. The magnitude of the acceleration

$$= \frac{490{\cdot}5 - 250}{50} = \underline{4{\cdot}81 \text{ m/s}^2}.$$

Q24 The rotor of an electrical generator is turned at 1000 revolutions/min. If the diameter of the rotor is 150 mm, calculate the speed of a point on its circumference in metres per second.

A24 Circumference = $\pi \times$ diameter = $150\pi \times 10^{-3}$ m.

The speed of a point on the circumference

$$= 150\pi \times 10^{-3} \times 1000/60 = \underline{7{\cdot}85 \text{ m/s}}.$$

TYPICAL TIME LIMIT FOR Q25–26: 4 min

Q25 State the difference between a scalar and a vector quantity, and give one example of each.

A25 A vector quantity has magnitude and direction, whereas a scalar quantity has magnitude only. Temperature is an example of a scalar quantity. Force is an example of a vector quantity.

Q26 If 2 forces, acting at a point, produce a resultant of 10 N at an angle of 90° to the horizontal, what is their equilibrant?

A26 Their equilibrant is a force of 10 N at an angle of −90° to the horizontal [that is, equal in magnitude but opposite in direction to the resultant].

TYPICAL TIME LIMIT FOR Q27: 5 min

Q27 (a) Two rods of differing metals are placed in an electrolyte to form a simple cell. Explain how you would use the electrochemical series to determine the polarity of the cell's electrodes.

(b) If one rod is replaced by a rod made of a metal which is closer in the electrochemical series to the metal of the other rod, what is the effect (if any) on the EMF of the cell?

A27 (*a*) The electrochemical series lists metals in descending order of their ability to form positive ions. Thus, if metal A is higher in the series than metal B, metal A forms positive ions more readily than metal B. If A and B are the electrodes of a simple cell, the positive ions leave A, causing it to become negatively charged. Thus, a metal higher in the series than another will be the negative electrode, and the lower metal will be the positive electrode.

(*b*) The EMF of the cell will reduce.

TYPICAL TIME LIMIT FOR Q28–31: 13 min

Q28 State the significant difference between the temperature coefficient of resistance of carbon and those of most other common conducting materials.

A28 Carbon has a negative temperature coefficient of resistance; most other common conducting materials have positive coefficients.

Q29 A circuit draws 250 mA from a 50 V DC supply when the only resistance in the circuit is at a temperature of 20°C. Later, the current is seen to have fallen to 240 mA. Assuming that the supply voltage has remained constant, and that the temperature coefficient of resistance of the resistive material is 0·004/°C, what is the new temperature of the resistance?

A29 By Ohm's law, the initial resistance at 20°C is $50/250 \times 10^{-3} = 200\ \Omega$. Now, the resistance, R ohms, at any temperature, t degrees Celsius, is given by

$$R = R_0(1 + \alpha t) \text{ ohms},$$

where R_0 is the resistance at 0°C (ohms), and α is the temperature coefficient of resistance (fractional change in resistance per degree Celsius).

$$\therefore R_0 = 200/(1 + 0{\cdot}004 \times 20) = 185{\cdot}2\ \Omega.$$

The final resistance is $50/240 \times 10^{-3} = 208{\cdot}3\ \Omega$, so that the value of t giving rise to that resistance is

$$t = (208{\cdot}3 - 185{\cdot}2)/185{\cdot}2 \times 0{\cdot}004 = \underline{31{\cdot}2°\text{C}}.$$

Q30 A battery of dry cells has an EMF of 24 V. When a load current of 100 mA is drawn from the battery, the terminal potential difference falls to 22 V. Calculate the load resistance and the internal resistance of the battery.

A30 The terminal voltage (22 V) drives a current of 100 mA through the load resistance. By Ohm's law, therefore, the load resistance

$$= 22/100 \times 10^{-3} = \underline{220\ \Omega}.$$

The load current flowing through the battery's internal resistance gives a reduction in terminal voltage of 2 V. Again by Ohm's law, the internal resistance

$$= 2/100 \times 10^{-3} = \underline{20\ \Omega}.$$

MATHEMATICS 1 1977–78

This set of model questions and answers illustrates the assessment procedures that students encounter in this unit, and includes the styles of both in-course and end-of-unit test papers. It is not representative of the questions set by any particular college.

The answers given illustrate what is expected of students in the time allowed. Where additional text is given for educational purposes, and does not form part of the answer expected of students, it is shown within square brackets.

Questions are given in italic type and answers in upright type. Answers to objective questions are given in bold upright type for additional clarity. Answers are positioned such that students may cover them and independently attempt the questions.

Q1–14 are multiple-choice objective questions. Students would normally be expected to tick or ring the correct answer. In the model answers below, the designations of the correct choices are printed to the right of the question in such a way that students may, if they wish, cover them up in order to check their answers after working through the questions. Q1–14 should be completed within 20 min.

Q1 Which of the following are correct?

(*a*) $22 + 7 + 393 - 59 = 336$
(*b*) $23 + 32 - 33 + 50 = 72$
(*c*) $569 - 649 + 77 = 3$
(*d*) $87 + 78 - 2 - 160 = 0$

(b)

Q2 Which of the following represents the simplification of $9(22 - 7 \times 3) - 4[6 - 2(7 - 5)]$*?*

(*a*) -1 (*b*) 17 (*c*) 1 (*d*) 10 **(c)**

Q3 The lowest common multiple (LCM) of the numbers 3, 5, 6 and 15 is

(*a*) 15 (*b*) 30 (*c*) 60 (*d*) 90 **(b)**

Q4 The highest common factor (HCF) of the numbers 273 and 390 is

(*a*) 13 (*b*) 26 (*c*) 21 (*d*) 39 **(d)**

Q5 The simplest form of $3\frac{7}{9} - \frac{104}{21} + \frac{79}{18}$ *is*

(*a*) $3\frac{5}{21}$ (*b*) $3\frac{1}{7}$ (*c*) $3\frac{3}{14}$ (*d*) $4\frac{5}{14}$ **(c)**

Q6 $\frac{5}{16}$ *expressed as a decimal is*

(*a*) 0·3125 (*b*) 0·4375 (*c*) 0·375 (*d*) 0·1875 **(a)**

Q7 0·0010162 expressed to 3 significant figures is,

(*a*) 0·001 (*b*) 0·00101 **(c)**
(*c*) 0·00102 (*d*) 0·001016

Q8 0·0821 as a percentage of unity is,

(*a*) 82·1% (*b*) 0·821% (*c*) 8·21% **(c)**

Q9 Which of the following give the evaluation of $1\frac{2}{9} + \frac{4 \cdot 95}{6 \cdot 3}$ *correct to 2 decimal places?*

(*a*) 2·0 (*b*) 2·01 (*c*) 2·0079 (*d*) 2·00 **(b)**

Q10 $1\frac{1}{2}$ *expressed as a percentage of 1500 is*

(*a*) 1% (*b*) 10% (*c*) 0·1% (*d*) 2·25% **(c)**

Q11 Which of the following ratios is nearest to one half?

(*a*) 3:8 (*b*) 39:79 (*c*) 42:79 (*d*) 7:16 **(b)**

Q12 Which of the following expresses 0·575 as a vulgar fraction in its lowest terms?

(*a*) $\frac{575}{1000}$ (*b*) $\frac{46}{80}$ (*c*) $\frac{115}{200}$ (*d*) $\frac{23}{40}$ **(d)**

Q13 Assuming that 1 inch = 2·54 cm, which of the following gives 1 foot as a percentage of 1 m?

(*a*) $33\frac{1}{3}\%$ (*b*) 30% (*c*) 30·48% (*d*) 25·4% **(c)**

Q14 $\frac{16}{9}$ *expressed as a mixed number with a recurring decimal is,*

(*a*) 1·777 (*b*) 1·7 (*c*) 1·7 (*d*) 1·77 **(b) or (d)**

Q15–39 are constructed-response objective questions. Again, the answers are arranged so that they may be covered up. This set of questions should be answered in 30 min.

Q15 $\frac{2}{3} + \frac{3}{5} + \frac{5}{6} + \frac{9}{10} =$ **3**

Q16 $168 \div 16 =$ **10·5**

Q17 $\frac{2}{3} \times \frac{9}{5} \times \frac{25}{6} =$ **5**

Q18 The LCM of 3, 6, 27, and 24 is **216**

Q19 The HCF of 36, 48, and 54 is **6**

Q20 2·0943 correct to 3 significant figures is **2·09**

Q21 0·003765 correct to 4 decimal places is **0·0038**

Q22 3·999 correct to one decimal place is **4·0**

Q23 25% of 160 is **40**

Q24 2·5% of 16 is **0·4**

Q25 $\frac{3^5 \times 3^0 \times 3^{-2}}{3 \times 3^2} =$ **1**

Q26 If £100 is divided between 3 people in the ratio of 1:2:2, the smallest amount received by any one of the three is **£20**

Q27 $\sqrt[3]{(27)} =$ **3**

Q28 $\sqrt[2]{(0 \cdot 25)} =$ **0·5**

Q29 $\sqrt[4]{(16)} =$ **2**

Q30 Using tables, write down $\log_{10} 39 \cdot 31$ **1·5945**

Q31 Using tables, find $\sqrt{(491 \cdot 2)}$ **22·16**

Q32 Using tables, find $\frac{1}{7 \cdot 9}$ **0·1266**

Q33 If $a = 1$, $b = -2$, *and* $c = 3$, *then*
$3c(a - b)(a + b) =$ **−27**

Q34 If $a = 2$ *and* $b = 3$, *then*
$3a^2b \div 5(b - a) =$ **7½**

Q35 If $5(x + 2) - 3(5x - 4) = 2$, *then* $x =$ **2**

Q36 Given that
$10x + 10y = 30$ *and* $20x - 10y = 0$, *then* $x =$ **x = 1**
and $y =$ **y = 2**

Q37 The denary number 8 expressed in binary form is **1000**

Q38 *The binary number 1111 expressed in denary form is* **15**

Q39 *The denary form of the addition of the binary numbers 1110 and 1010 is* **24**

Q40–49 are long and short-answer questions; the total time for the set of questions is 2½ hours. The percentage allocation of marks is shown beside each question.

Q40 *(a) With the aid of logarithmic tables, evaluate the following:*

(i) $\sqrt{(0{\cdot}00913)}$,

(ii) $\dfrac{5{\cdot}24^2 \times 0{\cdot}7219}{0{\cdot}023^2}$, *and*

(iii) $2{\cdot}51 \times \sqrt{(3{\cdot}91)} \times \left(7{\cdot}91^2 - \dfrac{595}{611}\right)$.

(b) Express the following in standard form:

(i) 21359, (ii) $0{\cdot}0021 \times 10^{-3}$, *and (iii)* $\dfrac{1440}{3}$. (15%).

A40 *(a) (i)*

No.	Log.
0·00913	$\bar{3}{\cdot}9605$ (÷ 2)
0·09555	$\bar{2}{\cdot}9802$

$\therefore \quad \sqrt{(0{\cdot}00913)} = \underline{0{\cdot}09555}.$

(ii)

No.	Log.	No.	Log.
5·24	0·7193 (×2)	0·023	$\bar{2}{\cdot}3617$ (×2)
$5{\cdot}24^2$	1·4386 (+)	$0{\cdot}023^2$	$\bar{4}{\cdot}7234$
0·7219	$\bar{1}{\cdot}8584$		
Numerator	$1{\cdot}2970$ (−)		
Denominator	$\bar{4}{\cdot}7234$		
37460	4·5736		

$\therefore \quad \dfrac{5{\cdot}24^2 \times 0{\cdot}7219}{0{\cdot}023^2} = \underline{3{\cdot}746 \times 10^4}.$

(iii)

No.	Log.
595	2·7745 (−)
611	$\bar{2}{\cdot}7860$
0·9738	$\bar{1}{\cdot}9885$

$\therefore \quad \dfrac{595}{611} = 0{\cdot}9738.$

No.	Log.
7·91	0·8982 (×2)
62·58	1·7964

$\therefore\ 7{\cdot}91^2 = 62{\cdot}58$ and $7{\cdot}91^2 - \dfrac{595}{611} = 61{\cdot}61.$

No.	Log.
3·91	0·5922 (÷ 2)
$\sqrt{(3{\cdot}91)}$	0·2961 (+)
2·51	0·3997 (+)
61·61	1·7897
305·8	2·4855

$\therefore\ 2{\cdot}51 \times \sqrt{(3{\cdot}91)} \times \left(7{\cdot}91^2 - \dfrac{595}{611}\right) = \underline{305{\cdot}8}.$

(b) (i) $21359 = \underline{2{\cdot}1359 \times 10^4}.$

(ii) $0{\cdot}0021 \times 10^{-3} = \underline{2{\cdot}1 \times 10^{-6}}.$

(iii) $\dfrac{1440}{3} = 480 = \underline{4{\cdot}8 \times 10^2}.$

Q41 *(a) The formula* $C = \dfrac{5}{9}(F - 32)$ *relates Celsius and Fahrenheit temperatures. Make F the subject of the formula.*

(b) Solve the simultaneous equations

$10x + 3y = 5$ *and* $15x + 6y = 15$. (4%)

A41 *(a)* $C = \dfrac{5}{9}(F - 32).$

$\therefore \quad 9C = 5F - 160$ or $5F = 9C + 160.$

$\therefore \quad \underline{F = \dfrac{9}{5}C + 32.}$

(b) $10x + 3y = 5. \quad \ldots\ldots (1)$

$15x + 6y = 15. \quad \ldots\ldots (2)$

Multiplying equation (1) by 2 gives

$20x + 6y = 10. \quad \ldots\ldots (3)$

Subtracting equation (2) from equation (3) gives

$5x = -5.$

$\therefore \quad \underline{x = -1.}$

Substituting for x in equation (1) gives

$-10 + 3y = 5.$

$\therefore \quad 3y = 15.$

$\therefore \quad \underline{y = 5.}$

Q42 *(a) (i) Express 30 in binary form, and*
(ii) Express the binary number 101011 in denary form.

(b) (i) Add the binary numbers 1001 and 1111, expressing the answer in binary form.
(ii) Repeat the addition of part (b) (i) by first changing the 2 numbers to denary form, and check the denary sum against the binary result of part (b) (i). (5%)

A42 *(a) (i)*

	Remainder:
2)30	
2)15	0
2) 7	1
2) 3	1
2) 1	1
0	1

Thus $30 = 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0,$

$= \underline{11110}$ in binary form.

(ii) $101011 = 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0,$

$= 32 + 0 + 8 + 0 + 2 + 1 = \underline{43}.$

(b) (i)

$$\begin{array}{r} 1001 \\ +\ 1111 \\ \hline 11000 \end{array}$$

(ii) $1001 = 1 \times 2^3 + 1 \times 2^0 = 9.$

$1111 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 15.$

$11000 = 1 \times 2^4 + 1 \times 2^3 = 24.$

Thus, the denary addition agrees with the binary addition of part *(b) (i)*.

Q43 *Of 50 candidates sitting an examination, 2 obtained marks of 90% or more, 10 candidates obtained between 75% and 90%, 25 between 50% and 75%, 10 between 40% and 50% and the remaining 3 candidates obtained less than 40%.*
(i) Complete the following tally chart to represent the above results.

Mark Range	*No. of Candidates*	*Percentage of Total Candidates*
Above 90%	*2*	*4*
75%–90%	*10*	
50%–75%		
40%–50%		
Below 40%		
Totals	*50*	*100*

(*ii*) *Represent the percentages in the form of a pie diagram and also as a bar chart.* (10%)

A43 (*i*)

Mark Range	No. of Candidates	Percentage of Total Candidates
Above 90%	2	4
75%–90%	10	20
50%–75%	25	50
40%–50%	10	20
Below 40%	3	6
Totals	50	100

(*ii*) The angular divisions required for the pie diagram are obtained as follows:

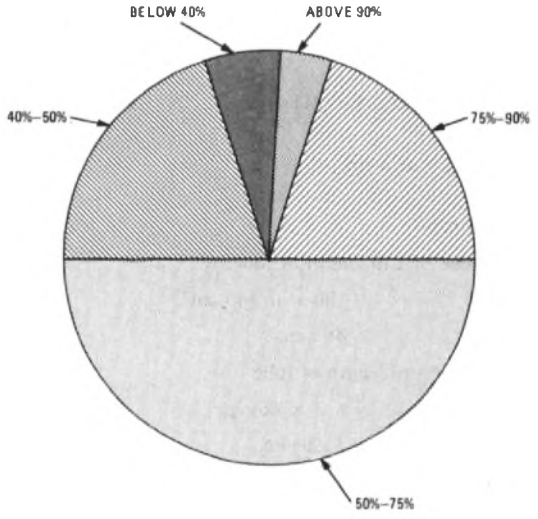
$$4\% \text{ of } 360^\circ = \frac{4}{100} \times 360^\circ = 14{\cdot}4^\circ$$

$$20\% \text{ of } 360^\circ = \frac{20}{100} \times 360^\circ = 72^\circ$$

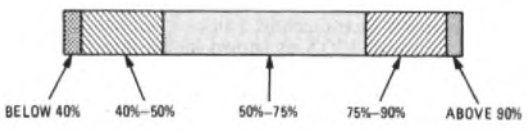
$$50\% \text{ of } 360^\circ = \frac{50}{100} \times 360^\circ = 180^\circ$$

$$6\% \text{ of } 360^\circ = \frac{6}{100} \times 360^\circ = 21{\cdot}6^\circ$$

The pie diagram is shown in sketch (*a*). A bar chart drawn to a suitable scale is shown in sketch (*b*).



(*a*)



(*b*)

Q44 (*a*) *Factorize the following expressions*:

(*i*) $ax - bx - ay + by$, *and* (*ii*) $\frac{27x^2}{5} + \frac{3x}{5}$.

(*b*) *Remove the brackets and simplify the following expression,*

$$-9\left\{5a + \frac{5}{3}(b^2 - a) - \frac{9}{5}\left[2a + b\left(\frac{25b}{27} + 1\right)\right]\right\}.$$

(*c*) *Find x from the following equation*

$$\frac{3x}{2} + 7 = 49 - (6x + 27).$$ (10%)

A44 (*a*) (*i*) $ax - bx - ay + by = x(a - b) - y(a - b)$,

$$= \underline{(a - b)(x - y)}.$$

(*ii*) $\frac{27x^2}{5} + \frac{3x}{5} = \underline{\frac{3}{5}x(9x + 1)}$.

(*b*) $-9\left\{5a + \frac{5}{3}(b^2 - a) - \frac{9}{5}\left[2a + b\left(\frac{25b}{27} + 1\right)\right]\right\}$,

$= -9\left[5a + \frac{5b^2}{3} - \frac{5a}{3} - \frac{9}{5}\left(2a + \frac{25b^2}{27} + b\right)\right]$,

$= -9\left(5a + \frac{5b^2}{3} - \frac{5a}{3} - \frac{18a}{5} - \frac{5b^2}{3} - \frac{9b}{5}\right)$,

$= -\frac{9}{15}(75a - 25a - 54a - 27b)$,

$= -\frac{3}{5}(-4a - 27b)$,

$= \frac{12a}{5} + \frac{81b}{5} = \underline{\frac{1}{5}(12a + 81b)}$.

(*c*) $\frac{3x}{2} + 7 = 49 - (6x + 27)$,

$= 49 - 6x - 27$.

$\therefore \quad \frac{3x}{2} + 6x = 22 - 7$.

$\therefore \quad 3x + 12x = 30$.

$\therefore \quad 15x = 30$.

$\therefore \quad \underline{x = 2}$.

Q45 (*a*) *Fig. 1 shows an equilateral triangle of side 2 units. Without using tables, state the value of each angle of the triangle and determine tan ∠ ABC.*

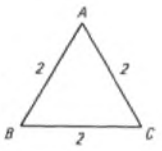


Fig. 1

(*b*) *Fig. 2 depicts a radio mast 100 m high, with an adjacent building of height 10 m. If the angle of elevation of the top of the mast seen from the corner of the roof nearest the mast is 85°, find x, the distance from the foot of the mast to the nearer side of the building.* (10%)

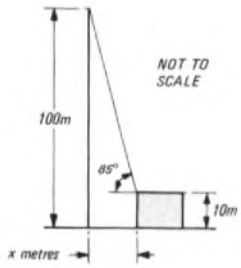


Fig. 2

A45 (*a*) Each angle of an equilateral triangle is 60°. In sketch (*a*), AD is perpendicular from A to BC, and, since this bisects BC, BD = DC = 1.

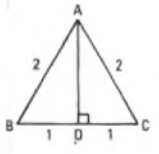
In triangle ABD, by the theorem of Pythagoras,

$$AD^2 = AB^2 - BD^2,$$

$$= 4 - 1 = 3.$$

$\therefore \quad AD = \sqrt{3}$.

Then, $\tan \angle ABC = \frac{AD}{BD} = \frac{\sqrt{3}}{1} = \underline{\sqrt{3}}$.



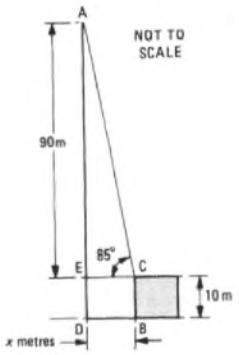
(*a*)

(*b*) Sketch (*b*) shows the mast and building. CE is drawn parallel to the ground-line DB, so that $x = DB = EC$ and $ED = CB = 10$ m. Hence, $AE = 100 - 10 = 90$ m.

In triangle AEC, $\tan \angle ACE = \frac{AE}{EC}$.

$\therefore \quad \tan 85° = \frac{90}{x}$.

$\therefore \quad x = \frac{90}{11{\cdot}43} = \underline{7{\cdot}87 \text{ m}}$.

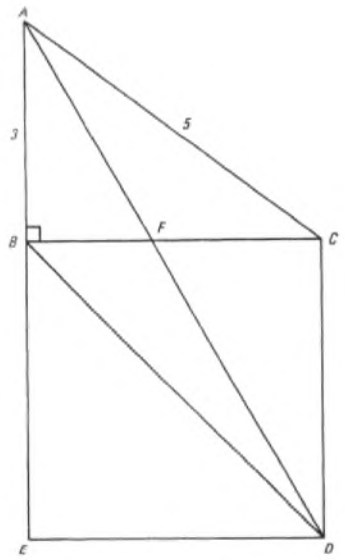


(*b*)

Q46 *In the figure, triangle ABC is right-angled at B, and BCDE is a square. AB = 3 units and AC = 5 units.*

(a) Determine the length of AD and, from the similar triangles ABF and AED, determine the length of BF.

(b) Work out the areas of triangles ABF, AFC and FCD correct to 3 significant figures in each case. (12%)



A46 (*a*) Since triangle ABC is right-angled,

$$AC^2 = AB^2 + BC^2,$$

or $$BC^2 = AC^2 - AB^2 = 5^2 - 3^2 = 16.$$

$\therefore \quad BC = 4$ units.

Since BCDE is a square,

$$BC = CD = DE = EB = 4 \text{ units}.$$

$\therefore \quad AE = AB + BE = 3 + 4 = 7$ units.

In triangle AED, right-angled at E,

$$AD^2 = AE^2 + ED^2,$$
$$= 7^2 + 4^2 = 49 + 16 = 65.$$

$\therefore \quad AD = \sqrt{65} = \underline{8{\cdot}062 \text{ units}}$.

Since triangles ABF and AED are similar,

$$\frac{BF}{ED} = \frac{AB}{AE}.$$

$\therefore \quad BF = \frac{4 \times 3}{7} = \frac{12}{7} = \underline{1{\cdot}7143 \text{ units}}$.

(*b*) The area of triangle $ABF = \frac{1}{2} \times AB \times BF$,

$$= \tfrac{1}{2} \times 3 \times 1{\cdot}7143,$$
$$= \underline{2{\cdot}57 \text{ units}}, \text{ correct to 3 significant figures.}$$

Area of triangle AFC = area of triangle ABC − area of triangle ABF,

$$= \tfrac{1}{2} \times 3 \times 4 - 2{\cdot}57,$$
$$= \underline{3{\cdot}43 \text{ units}}, \text{ correct to 3 significant figures.}$$

Area of triangle $FCD = \frac{1}{2} \times FC \times CD$,

$$= \tfrac{1}{2}(4 - 1{\cdot}7143) \times 4,$$
$$= \underline{4{\cdot}57 \text{ units}}, \text{ correct to 3 significant figures.}$$

Q47 (*a*) *Express in radians:*

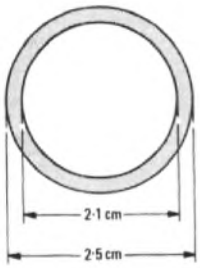
(i) 180°, and (ii) 44° 20′.

(b) A metal tube has an outside diameter of 2·5 cm and an inside diameter of 2·1 cm. Calculate, in kilograms, the weight per metre run of the tube if the metal weighs 8·3 g/cm³. (10%)

A47 (*a*) (*i*) $180° = \underline{\pi \text{ rad}}$.

(*ii*) $44° 20' = \underline{0{\cdot}7738 \text{ rad}}$ (from tables).

(*b*) A cross-section of the tube is shown in the sketch. The cross-sectional area of the metal is the area of the outer circle minus the area of the inner circle,



$$= \frac{\pi}{4} \times 2{\cdot}5^2 - \frac{\pi}{4} \times 2{\cdot}1^2 \text{ cm}^2,$$

$$= \frac{\pi}{4}(2{\cdot}5^2 - 2{\cdot}1^2) \text{ cm}^2,$$

$$= \frac{\pi}{4}(2{\cdot}5 + 2{\cdot}1)(2{\cdot}5 - 21) \text{ cm}^2,$$

$$= \frac{\pi}{4} \times 4{\cdot}6 \times 0{\cdot}4 \text{ cm}^2,$$

$$= 0{\cdot}46\pi \text{ cm}^2.$$

$\therefore$ the volume of 1 m length of tube,

$$= 100 \times 0{\cdot}46\pi \text{ cm}^3,$$
$$= 46\pi \text{ cm}^3,$$

and the weight of 1 m length of tube

$$= 8{\cdot}3 \times 46\pi \text{ g},$$
$$= 1199{\cdot}4 \text{ g}.$$

Hence, the weight per metre run is $\underline{1{\cdot}20 \text{ kg}}$.

Q48 (*a*) *Draw a graph of $y = \sin \theta$, for values of θ between 0 and π rad, by projection from a unit rotating vector. Explain your construction.*

(b) Read from your graph the values of sin 48° and sin 72°. (14%)

A48 (*a*) With centre O and radius 1 unit, a semicircle was drawn on the horizontal diameter X′OX as shown in the sketch. The semicircle was then divided into 30° sectors by the radii OP, OQ, etc.

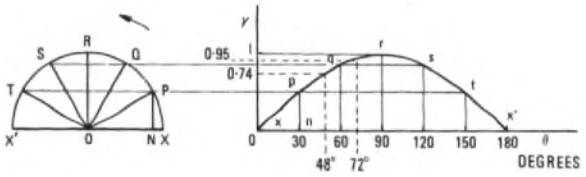
Two axes, $0x$ and $0y$ were then drawn to the right of the semicircle so that $0x$ is collinear with the diameter of the semicircle. The x-axis was then divided, using a suitable scale, into equal parts each representing 30°, up to a value of 180°.

The perpendicular PN was then drawn from O to OX.

Then, in triangle OPN, $\frac{PN}{OP} = \sin 30°$.

$\therefore$ PN = 1 × sin 30°, since OP = 1 unit.

A horizontal projection of the point P was then drawn to intersect the ordinate erected at n, the point on the x-axis corresponding to 30° at the point p; np = NP = sin 30°. Similarly then points Q, R, etc. were all projected horizontally to intersect with their corresponding ordinates at 60°, 90°, etc. at the points q, r, etc. A smooth curve drawn through these points of intersection was then the graph of $y = \sin \theta$, from $\theta = 0$ to $\theta = 180°$ at X′.



(*b*) Ordinates, shown dotted, were erected at $\theta = 48°$ and $\theta = 72°$; the values read from the graph are:

$$\sin 48° = \underline{0{\cdot}74} \text{ and } \sin 72° = \underline{0{\cdot}95}.$$

Q49 (*a*) *An experiment to show the variation in the volume, V cm³, of a given mass of gas with temperature, t°C, gave the following results:*

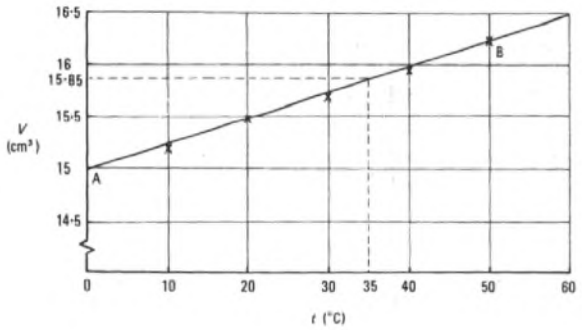
V (cm³)	15·24	15·48	15·7	15·96	16·20	16·49
t (°C)	10	20	30	40	50	60

Draw a suitable straight-line graph to show these results, plotting the values of t°C along the horizontal axis.

(*b*) *What would be the volume of gas at 0°C, and at what temperature did the volume reach 15·85 cm³?*

(*c*) *What is the gradient of the line in centimetres cubed per degree Celsius?* (10%)

A49 (*a*) The graph is shown in the sketch.



(*b*) At 0°C, the volume of the gas is $\underline{14{\cdot}975 \text{ cm}^3}$, and it reached a volume of 15·85 cm³ at a temperature of $\underline{35°\text{C}}$.

(*c*) Using points A and B shown in the sketch, the gradient of the graph

$$= \frac{16{\cdot}225 - 14{\cdot}975}{50 - 0}$$

$$= \frac{1{\cdot}25}{50} = \underline{0{\cdot}025 \text{ cm}^3/°\text{C}}.$$

[*Tutorial notes:* (*i*) The sketch shown has been reduced in size for ease of reproduction; suitable scales would be 1 cm for 5°C and 1 cm for 0·25 cm³.

(*ii*) Although the smallest value of *V* given was 15·24 cm³, the vertical scale was started at 14·5 cm³ to allow extension of the graph back to 0°C for part (*b*) of the question. (Moral: read the whole question before starting.)

(*iii*) The straight line was drawn to pass as close as possible to all points. There is obviously a small margin of choice, which may result in slightly different values of gradient.

(*iv*) To obtain the gradient of the straight line from the coordinates of 2 points on it, the points chosen should lie on the drawn line and should not include any plotted points (marked with a cross) unless such points are precisely on the line.

(*v*) The points, such as A and B of the sketch, should be widely separated, to ensure greater accuracy, and can be chosen for ease of calculation.]

LINE AND CUSTOMER APPARATUS 1 1977–78

This set of model questions and answers illustrates the assessment procedures that students encounter in this unit, and includes the styles of both in-course and end-of-unit test papers. It is not representative of the questions set by any particular college.

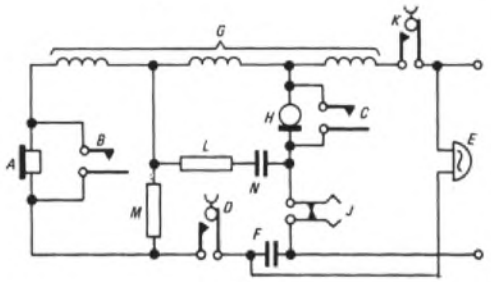
The answers given illustrate what is expected of students in the time allowed. Where additional text is given for educational purposes, and does not form part of the answer expected of students, it is shown within square brackets.

Questions are given in italic type and answers in upright type. Answers to objective questions are given in bold upright type for additional clarity. Where possible, answers are positioned such that students may cover them and independently attempt the questions.

Q1 *The sketch shows the circuit diagram of a telephone.*

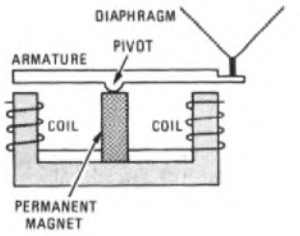
Match the numbered functions below to the lettered components in the diagram. (*2 min*)

(*1*) *Signals to the exchange that a call is to be made.*	**Component: K**
(*2*) *Converts sound waves into electrical signals.*	**H**
(*3*) *Indicates an incoming call.*	**E**
(*4*) *Relays to the exchange the number of a required telephone subscriber.*	**J**
(*5*) *Prevents the exchange from always returning engaged signals to incoming calls.*	**F**



Q2 *Make a simple drawing of a rocking-armature receiver, indicating the diaphragm, armature, permanent magnet, pivot and coils. What purpose is served by the permanent magnet?* (*8 min*)

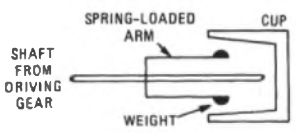
A2



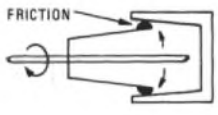
If no permanent magnet were present, there would be no magnetic bias, and the armature would move in response to magnetic *attractions* due to both positive and negative excursions of signal current. Hence, the armature would vibrate twice as rapidly as it should, generating pressure waves at twice the required frequency; that is, frequency-doubling would result.

Q3 *Explain how the speed of a dial is controlled, illustrating your answer with simple sketches.* (*8 min*)

A3 Dial speed is controlled by a governor using the principle of centrifugal force. The governor controls the speed of return of the dial, and is driven from the main spindle through step-up gearing.



(*a*)

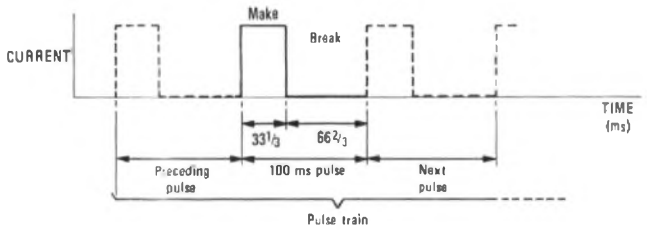


(*b*)

Sketch (*a*) shows the governor stationary. When the governor is driven at high speed, the weights move outwards until they come into contact with the inside of the enshrouding cup, as shown in sketch (*b*). The friction thus generated regulates the speed at which the dial rotates.

Q4 Apart from the speed of a train of dial pulses, what important feature does a dial pulse possess? Illustrate your answer by a simple sketch, indicating the length of time occupied by a single pulse and by its constituent parts. (*6 min*)

A4 The important feature of a dial pulse (apart from speed) is the ratio of the MAKE period to the BREAK period; that is, the ratio of the time for which the pulsing contacts are closed (when current can flow) to that for which they are open (when current cannot flow).



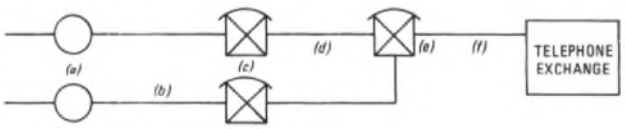
Note Students would not be expected to include the adjacent pulses, which are shown here for completeness

Q5 The drawings represent telephone instruments. Insert the appropriate words in the statements below. (*1 min*)

Telephone A illustrates an instrument using ..... **loop** *calling, which is used in* .....**direct-exchange-line and PBX/PABX** *installations.*

Telephone B illustrates ..... **earth-one-leg** *calling, which is used in* ..... **shared-service** *installations*

Q6 Name the designated items in the diagram. (*2 min*)



A6 (*a*) Distribution points (*b*) Distribution cable
(*c*) Secondary cross-connexion points (*d*) Branch cable
(*e*) Primary cross-connexion point (*f*) Main cable

Q7 Explain why telephone exchanges are sited in the middle of towns (where land is expensive) instead of on industrial estates (which are usually on the outskirts of towns). (*5 min*)

A7 A considerable part of the capital investment needed to provide a town with its telephone service is accounted for by underground cable and related plant. If the exchange were on the outskirts of a town, more cable would be needed to service the centre of the town (where telephones are most numerous). Also, junction cables would have to follow the road pattern into the town centre before they could be routed to a second exchange in another part of the town's outskirts.

Q8 Name (*a*) *three commonly-used metallic conductors and* (*b*) *one commonly-used non-metallic conductor.* (*1 min*)

A8 (*a*) Silver, nickel-silver, copper, aluminium, gold, mercury.
(*b*) Carbon, the earth.

[More than the required number have been given for completeness].

Q9 Which component of a modern telephone would you suspect of being faulty for each of the following symptoms described by a customer? (*2 min*)

(*a*) *"It never used to be like this, even though I know the exchange is just round the corner, but now it's so loud that I have to hold it away from my ear."* — **Regulator**
(*b*) *"Whenever I use the dial, I get these terrible clicks in my ear."* — **Dial-off-normal springs**
(*c*) *"When the 'phone rings, I pick up the receiver and it just keeps on ringing, and I get burr-burr in the receiver."* — **Switch-hook springs**

Q10 (*a*) *From the following list, select the primary coefficients of a cable:* (*i*) *reactance,* (*ii*) *inductance,* (*iii*) *phase shift,* (*iv*) *resistance,* (*v*) *porosity,* (*vi*) *length,* (*vii*) *cross-section,* (*viii*) *heat resistance,* (*ix*) *conductance,* (*x*) *decadence,* (*xi*) *capacitance,* (*xii*) *ductance.*
(*b*) *State the agreed resistance and transmission limits for a subscriber's line in the UK.* (*2 min*)

A10 (*a*) **(ii), (iv), (ix), (xi)**
(*b*) 1000 Ω; 10 dB loss at 1600 Hz.

Q11 (*a*) *Insert the missing term in: "A . . . is necessary to assess future telephone needs".*
(*b*) *Describe how the subject of part* (*a*) *is carried out.* (*8 min*)

A11 (*a*) Development study.
(*b*) A development study looks at a period of up to 20 years ahead. All relevant planning bodies are consulted during the course of a field survey which establishes the locations of existing and potential customers' premises. From this information (which is recorded on large-scale maps), the change in the number of telephones required is estimated. For every fifth year of the period, a forecast of the number of telephones required at that date is made; these forecasts are known as *base-date* figures. The estimates are used as a basis for the provision of line plant.

Q12 With reference to a telephone exchange, state the meaning of the term "grade of service". (*3 min*)

A12 The grade of service is the ratio of the number of calls permitted to fail (due to designed insufficiency of switching equipment) to the total number of calls offered during the busy hour.

Q13 A telephone exchange has all its multiple in use. There are 3534 exclusive-line customers and 733 pairs of shared-service customers. Select the multiple size from the list below. (*1 min*)

(*a*) *5000* (*b*) *3900*
(*c*) *4267* (*d*) *4000*

Multiple size: (a)

Q14 With reference to external cables, state what is meant by: (*a*) *a pair,* (*b*) *a quad,* (*c*) *the core,* (*d*) *the moisture barrier, and* (*e*) *the sheath.* (*6 min*)

A14 (*a*) A pair consists of 2 insulated wires twisted together throughout the length of a cable.
(*b*) A quad is 4 insulated wires twisted together throughout the length of a cable.
(*c*) The core includes everything within the cable's sheath.
(*d*) The moisture barrier is an aluminium-foil layer bonded to the inside of a polyethylene sheath. [The barrier is necessary because polyethylene sheaths allow the passage of small quantities of water vapour; that is, they are porous.]
(*e*) The sheath is the outermost covering of a cable.

Q15 What is the most important factor considered when deciding the size of plant for a particular junction route into and out of an exchange? (*1 min*)

A15 The highest number of instantaneous telephone calls.

Q16 Describe 2 methods of attracting the attention of a called customer, and say where these would be used. (*2 min*)

A16 [For completeness, 5 methods are given.]
(*a*) The method most commonly used in domestic and business telephone instruments is the AC bell.

(*b*) Electronic buzzers are used on certain switchboards.
(*c*) Tone-callers are used on Trimphones.
(*d*) Lamps are used on key-and-lamp units, or are incorporated into the handsets of 2 or more telephones grouped closely together. They may also be used for deaf customers.
(*e*) On older types of switchboard, electromechanical doll's-eye indicators or flap indicators are used.

Q17 The following statements refer to the use of concrete in joint-box construction. State which of them are true and which are false. (1 min)

(*a*) *Concrete can be formed to the required shape and size.* **True**
(*b*) *It is impervious to water.* **False**
(*c*) *It is a good electrical insulator.* **False**
(*d*) *If too much water is used in the mix, the concrete will be weakened.* **True**

Q18 List 3 facilities offered by a public call office. (2 min)

A18 (*a*) Access to a telephone for people without one.
(*b*) Access to a telephone in public places, or in remote rural areas.
(*c*) Access to the emergency services.

Q19 Match the following materials and components. Your answers should each take the form of a letter and a number. (2 min)

(*a*) *Zinc*
(*b*) *Silver*
(*c*) *Polished anthracite*
(*d*) *Copper*
(*e*) *Steel*
(*f*) *Aluminium*
(*g*) *PVC*

(*1*) *Internal-cable conductor*
(*2*) *Transmitter electrode surface*
(*3*) *Low-current relay contacts*
(*4*) *Receiver diaphragm*
(*5*) *Internal-cable insulation*
(*6*) *Transmitter granules*

(*h*) *Polystyrene*
(*i*) *Gold*
(*j*) *Nickel*

A19 **d1** **i2** **b3** **f4** **g5** **c6**

Q20 Indicate whether the following statements are true or false. (1 min)

(*a*) *There is no limit to the number of bells that can be connected in series.* **False**
(*b*) *When several telephones are connected to an exchange line, their transmission circuits are connected in parallel.* **True**
(*c*) *The induction coil ensures the correct DC supply voltage to the transmitter.* **False**

Q21 Indicate by ticks those of the following that are taken into account when deciding the charge for a call. (1 min)

(*a*) *Distance between telephone and parent exchange*
(*b*) *Season of year*
(*c*) *Distance between calling and called telephones* ✓
(*d*) *Time of day* ✓
(*e*) *Whether caller is residential or business customer*
(*f*) *Whether caller lives in high-class residential area*
(*g*) *Time that the call takes* ✓

Q22 Define (a) a conductor, and (b) an insulator. (2 min)

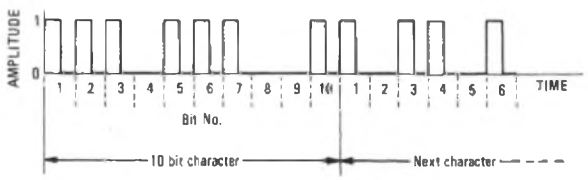
A22 (*a*) A conductor is a material that offers low resistance to the passage of electric current.
(*b*) An insulator is a material that offers high resistance to the passage of electric current.

SCOTEC: INTRODUCTION TO TELECOMMUNICATION SYSTEMS 1 1977–78

This set of model questions and answers illustrates the assessment procedures encountered by students of this subject.

Q1 Draw a typical digital waveform. State the function of each binary digit (bit) or group of bits. (12 min)

A1



A typical digital waveform is shown in the sketch. Pulses represent binary state 1 in the information carried by the waveform, and the absence of a pulse indicates binary state 0. The waveform returns to zero after each pulse. Each character in the waveform contains 10 bit, the functions of which are listed in the table.

Bit Nos.	Function
1 and 10	START and STOP bits: used to synchronize the receiver with the transmitter
2	Parity bit: used to detect errors in the waveform introduced during transmission
3–9	Information bits: used to carry character information in the form of binary numbers

Q2 Match the channel descriptions in the first list with the multiplexing systems in the second. Record your answer by writing the appropriate numbers in the panel provided. The descriptions in the first list may apply to more than one of the systems in the second. (3 min)

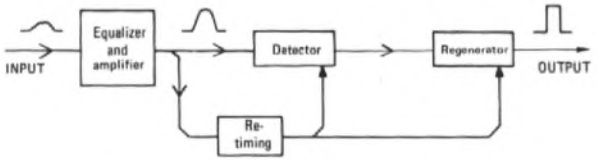
1 Exclusive path
2 Common path
3 Exclusive time
4 Simultaneous
5 Exclusive frequency
6 Common frequency

(*a*) *Time-division multiplex*
(*b*) *Frequency-division multiplex*
(*c*) *Space-division multiplex*

(*a*)	2	3	6
(*b*)	2	4	5
(*c*)	1	4	6

Q3 Describe the principle of operation of a regenerative repeater suitable for a digital transmission system. (15 min)

A3



The block diagram of a regenerative repeater is shown in the sketch. The function of a regenerative repeater is to produce at its output a replica of the original transmitted signal.

The incoming signal will be attenuated by the preceding cable, the higher-frequency components being attenuated more than the lower-frequency components. The original signal is thus distorted as well as attenuated.

The attenuation/frequency characteristic of the equalizer and amplifier is arranged to compensate for the distortion introduced by the cable, and pulses are thus produced that are suitable for the detector and retiming stages. The retiming stage derives timing pulses from the incoming signal and uses them to control the duration and rate of pulses produced by the regenerator.

Timing pulses are also applied to the detector, which produces an output signal when the input exceeds a predetermined amplitude coincident with a timing pulse, indicating the presence of a pulse in the input signal.

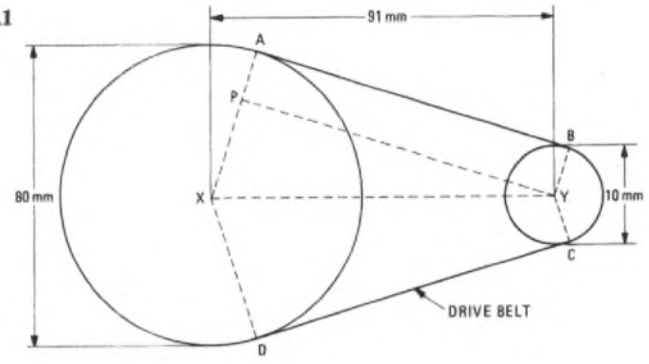
The outputs from the detector and the retiming stage are applied to the regenerator, which produces rectangular pulses of the correct duration and at the correct rate. Thus, the original signal is regenerated.

SCOTEC MATHEMATICS 1/2 1977–1978

SCOTEC Mathematics 1 and 2 are half-value subjects at stages 1 and 2, but are both studied with other stage-1 subjects.

Q1 Two pulley wheels are connected together by a belt drive. The diameter of the larger pulley is 80 mm and the diameter of the smaller pulley is 10 mm. If the pulley centres are 91 mm apart, calculate the total length of the belt drive. *(10 min)*

A1



The pulley system is shown in the sketch. Points X and Y are the centres of the pulleys and points A, B, C and D are points of tangency; YP is parallel to BA, meeting the radius of the larger pulley at point P.

The total length of the belt drive is

$$\text{line AB} + \text{line CD} + \text{arc DA} + \text{arc BC}.$$

Since AB is tangential to the pulleys, it meets the radii XA and YB at right angles.

Since AB is parallel to PY, and AP is parallel to BY, ABYP is a rectangle with

$$\text{AB} = \text{PY, and}$$

$$\text{AP} = \text{BY} = 5 \text{ mm}.$$

$$\therefore \quad \text{PX} = \text{AX} - \text{AP} = 40 - 5 = 35 \text{ mm}.$$

In triangle PXY, $\angle$XPY is 90° (supplementary to $\angle$APY) and therefore, by Pythagoras' theorem,

$$\text{XY}^2 = \text{PX}^2 + \text{PY}^2.$$

$$\therefore \quad \text{PY}^2 = \text{XY}^2 - \text{PX}^2 = 91^2 - 35^2 = 7056.$$

$$\therefore \quad \text{PY} = \sqrt{7056} = 84 \text{ mm} = \text{AB}.$$

By symmetry, $\text{CD} = 84$ mm.

Since $\angle\text{XPY} = 90°$,

$$\sin \angle\text{PXY} = \frac{\text{PY}}{\text{XY}} \quad \left(\frac{\text{opposite side}}{\text{hypotenuse}}\right),$$

$$= \frac{84}{91} = 0{\cdot}9231.$$

$$\therefore \quad \angle\text{PXY} = 67{\cdot}38° = 1{\cdot}176 \text{ rad}.$$

By symmetry, $\angle\text{DXY} = 1{\cdot}176$ rad.

$$\therefore \quad \angle\text{AXD (obtuse)} = \angle\text{AXY} + \angle\text{DXY},$$

$$= 1{\cdot}176 + 1{\cdot}176 = 2{\cdot}352 \text{ rad}.$$

$$\therefore \quad \angle\text{AXD (reflex)} = 2\pi - 2{\cdot}352 = 3{\cdot}931 \text{ rad}.$$

$$\therefore \quad \text{arc DA} = \text{reflex angle AXD} \times \text{radius AX},$$

$$= 3{\cdot}931 \times 40 = 157{\cdot}24 \text{ mm}.$$

Similarly, for the smaller pulley, it can be shown that

$$\text{arc BC} = 11{\cdot}76 \text{ mm}.$$

Therefore the total length of the drive belt is

$$84 + 84 + 157{\cdot}24 + 11{\cdot}76,$$

$$= \underline{337 \text{ mm}}.$$

Q2 Given the relationship $N = 2^H$,

(a) express H as a logarithmic function of N,

(b) if $\log_2 P = -H$, find the relationship between N and P, and

(c) if H is 2·5, find the values of N and P, without using tables. Express your answer in terms of $\sqrt{2}$. *(10 min)*

A2 *(a)* $N = 2^H$.

$$\therefore \quad \underline{\log_2 N = H}$$

(b) $\log_2 P = -H$.

$$\therefore \quad H = -\log_2 P \text{ and, from part } (a),$$

$$H = \log_2 N.$$

$$\therefore \quad \log_2 N = -\log_2 P.$$

$$\therefore \quad \log_2 N + \log_2 P = 0.$$

$$\therefore \quad \log_2 (N \times P) = 0.$$

But, the logarithm (to any base) of 1 is 0.

$$\therefore \quad \log_2 (N \times P) = \log_2 1.$$

$$\therefore \quad NP = 1$$

$$\underline{N = \frac{1}{P} \text{ or } P = \frac{1}{N}}.$$

(c) Substituting $H = 2{\cdot}5$ in $N = 2^H$ gives

$$N = 2^{2{\cdot}5} = 2^{5/2},$$

$$= \sqrt{(2^5)} = \sqrt{(2^2 + 2^1)},$$

$$= 2\sqrt{2}.$$

But, from part *(b)*, $P = \frac{1}{N}$.

$$\therefore \quad \underline{P = \frac{1}{2\sqrt{2}}}.$$

THE TIME ALLOWED FOR Q3–12 is 10 min.

Q3 Which of the following is the standard form of 0·00624?

(a) 624×10^5 *(b)* $6{\cdot}24 \times 10^{-3}$

(c) $0{\cdot}624 \times 10^{-2}$ *(d)* $6{\cdot}2 \times 10^{-3}$ **(b)**

Q4 The expression $(2^2 \times 5^6 \times 7^4)^{1/2}$ with the brackets removed is,

(a) $2^4 \times 5^{12} \times 7^8$ *(b)* $2^{5/2} \times 5^{13/2} \times 7^{9/2}$

(c) $2^0 \times 5^4 \times 7^2$ *(d)* $2 \times 5^3 \times 7^2$ **(d)**

Q5 The solution of the equation $7 = 13 - \frac{6}{(x+2)}$ is

(a) $x = -2$ *(b)* $x = 0$ *(c)* $x = 1$ *(d)* $x = -1$ **(d)**

Q6 The number 0·076523 correct to 3 decimal places is

(a) 0·077 *(b)* 0·0765 *(c)* 0·08 *(d)* 0·076 **(a)**

Q7 In a circle, the part enclosed by an arc and 2 radii is the

(a) chord (b) sector (c) segment (d) radian. **(b)**

Q8 Which one of the following pairs of points lies on the straight line whose equation is $y = 3x - 2$?

(a) $(1, -1)$ *(b)* $(2, 1)$ *(c)* $(-1, -1)$ *(d)* $(\frac{1}{3}, 0)$ **(d)**

Q9 *The value of* $10^{0.67} \times 10^{0.85} \times 10^{0.48}$ *is*

(*a*) 84 (*b*) 100 (*c*) 1000 (*d*) 1648 **(b)**

Q10 *If* $\log_y A = -x$, *which of the following represents A*

(*a*) $\frac{1}{yx}$ (*b*) $\frac{1}{y^{-x}}$ (*c*) $-xy$ (*d*) x^{-y} **(a)**

Q11 *In Boolean algebra, which one of these expressions gives the answer 1*

(*a*) $\bar{1} + 0 + \bar{1} + 0$ (*b*) $\bar{1}.0.1.\bar{0}.1$
(*c*) $\bar{1}.1.1.1$ (*d*) $\bar{0}.1.1.\bar{0}$ **(d)**

Q12 *In a right-angled triangle, the tangent of one of the angles is 0·75. If the side opposite this angle is 3 mm long, what is the length of the hypotenuse?*

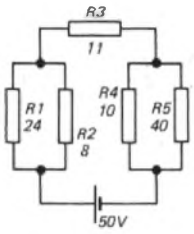
(*a*) 3 mm (*b*) 3·5 mm (*c*) 4 mm (*d*) 5 mm **(d)**

SCOTEC: ELECTRICAL AND ENGINEERING PRINCIPLES 1 1977–78

Electrical and Engineering Principles is a double-length subject at stage 1. This set of model questions and answers illustrates the assessment procedures encountered by students of this subject.
Typically, 20 min would be allocated to Q1, and 10 min each to Q2 and Q3 (total: 40 min).

Q1 (*a*) *For the circuit shown, calculate*

(*i*) *the total current,*
(*ii*) *the current in R2,*
(*iii*) *the potential difference across R5, and*
(*iv*) *the power dissipated in R1.*



(*b*) *What value of resistance would be required to alter the total current to 1·6 A, and how would it be connected?*

A1 (*a*) (*i*) The equivalent resistance, $R_{1//2}$, of resistors R1 and R2 is given by

$$\frac{1}{R_{1//2}} = \frac{1}{R_1} + \frac{1}{R_2}. \qquad \ldots\ldots (1)$$

Rearranging equation 1 gives

$$R_{1//2} = \frac{R_1 R_2}{R_1 + R_2} = \frac{24 \times 8}{24 + 8} = 6\ \Omega.$$

Similarly, $R_{4//5} = \frac{10 \times 40}{10 + 40} = 8\ \Omega.$

Therefore, the total resistance of the circuit is

$$R_{1//2} + R_3 + R_{4//5} = 6 + 11 + 8 = 25\ \Omega.$$

By Ohm's law, the total current is the total voltage divided by the total resistance, and is thus given by

$$I_T = 50/25 = \underline{2\ A.}$$

(*ii*) The voltage across parallel resistors R1 and R2 is

$$I_T \times R_{1//2} = 2 \times 6 = 12\ V.$$

Therefore the current in R_2 is

$$\text{(voltage across R2)} \div R_2 = 12/8 = \underline{1{\cdot}5\ A.}$$

(*iii*) The voltage across R5 is that across parallel resistors R4 and R5 and is given by

$$I_T \times R_{4//5} = 2 \times 8 = \underline{16\ V.}$$

(*iv*) The power dissipated in R1 is given by

$$\text{(voltage across R1)}^2 \div R_1 = 12^2/24 = \underline{6\ W.}$$

(*b*) If the total current reduces to 1·6 A, the total resistance must increase to $50/1{\cdot}6 = 31{\cdot}25\ \Omega$.
Thus, the increase in the resistance of the original circuit must be $31{\cdot}25 - 25 = \underline{6{\cdot}25\ \Omega.}$

The additional 6·25 Ω resistor must be connected in series with the original circuit.

Q2 *In Fig. 1, an ideal inductor of 450 mH is connected to a 240 V, 50 Hz supply.*

(*a*) *Sketch the relationship between the voltage and current waveforms in the circuit.*

(*b*) *Calculate the current in the circuit.*

(*c*) *If the frequency of the supply were to be increased, what would happen to the current? Give reasons for your answer.*

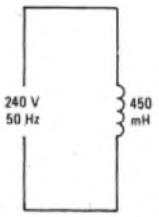
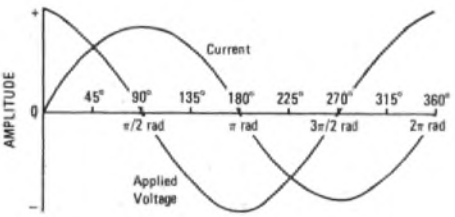


Fig. 1



(*a*)

A2 (*a*) The relationship is shown in sketch (*a*). In a purely inductive circuit, the current lags the voltage by 90° (that is, $\pi/2$ rad).

(*b*) The current, *I*, in the circuit is given by the applied voltage, *V*, divided by the inductive reactance. The inductive reactance is $2\pi fL$ ohms, where *f* is the frequency (hertz) and *L* the inductance (henrys).

$$\therefore\ I = 240/(2\pi \times 50 \times 450 \times 10^{-3}) = \underline{1{\cdot}7\ A.}$$

(*c*) If the frequency increases, the inductive reactance (given by $2\pi fL$) also increases. Since $I = V/2\pi fL$, the current thus decreases.

Q3 (*a*) (*i*) *Explain briefly what conditions are necessary for the production of an induced EMF in a conductor.*
(*ii*) *Upon what factors does the value of this EMF depend?*

(*b*) *A conductor, 10 cm long and at right angles to a magnetic field of flux density 40 mT, is moved through that field at a velocity of 10 m/s. What is the value of the induced EMF?*

A3 (*a*) (*i*) An EMF is induced in a conductor

(1) when the conductor is moved through a magnetic field, provided that a component of the conductor's velocity acts at right angles to the field, or
(2) when the conductor is stationary in a magnetic field, the magnitude of which is changing, provided there is a component of the field at right angles to the conductor.

(*ii*) The value of the induced EMF, *E*, depends on the flux density of the magnetic field, *B* teslas, the length of conductor within the field, *l* metres, and the (relative) velocity at which the conductor moves through the field, *v* metres/second.

Thus $E = Blv$ volts.

(*b*) $E = Blv = 40 \times 10^{-3} \times 10 \times 10^{-2} \times 10\ V,$
$= \underline{40\ mV.}$

CORRECTION

LINE PLANT PRACTICE B 1977

(*Supplement*, Vol. 71, Oct. 1978, p. 54)

A2 In referring to the speed of the cable ship, because of the closer spacing of repeaters currently being employed, it would be more realistic to say, "The cable ship maintains a constant speed of 9 km/h when laying cable; this speed drops to approximately 3 km/h when a repeater is laid."

Published by *The Post Office Electrical Engineers' Journal*, 2–12 Gresham Street, London EC2V 7AG,
and printed in Great Britain by Unwin Brothers Limited, Old Woking, Surrey