AFFIX SEAL HERE

CANDIDATE – PLEASE NOTE!

You must sign below and return this booklet with the Answer Sheet. Failure to do so may result in disqualification.

Signature

FORM TP 2009242

TEST CODE 02238010

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

Unit 2 - Paper 01

90 minutes

02 JUNE 2009 (p.m.)

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 90 minutes to answer them.
3. Do not be concerned that the answer sheet provides spaces for more answers than there are items in this test.
2. In addition to this test booklet, you should have an answer sheet.
4. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.
5. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

Which of the following lists one scalar quality and one vector quantity?

(A) force : velocity
(B) mass : temperature
(C) potential energy : volt
(D) momentum : pressure

Sample Answer

The best answer to this item is "momentum : pressure", so answer space (D) has been shaded.

6. If you want to change your answer, be sure to erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, omit it and go on to the next one. Your score will be the total number of correct answers.
8. You may do any rough work in this booklet.
9. Figures are not necessarily drawn to scale.
10. The use of non-programmable calculators is allowed.

AFFIX SEAL HERE

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

LIST OF PHYSICAL CONSTANTS

Speed of light in free space	c	=	3.00×10^{8} m s^{-1}
Permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
Permittivity of free space	ε_0	=	8.85×10^{-12} F m^{-1}
	$\frac{1}{4\pi\varepsilon_0}$	=	9.0×10^{9} m F^{-1}
Elementary charge	e	=	1.60×10^{-19} C
The Planck constant	h	=	6.63×10^{-34} J s
Unified atomic mass constant	u	=	1.66×10^{-27} kg
Rest mass of electron	m_e	=	9.11×10^{-31} kg
Rest mass of proton	m_p	=	1.67×10^{-27} kg
Acceleration due to gravity	g	=	9.81 m s^{-2}
1 Atmosphere	Atm	=	1.00×10^{5} N m^{-2}
Avogadro's number	N_A	=	6.02×10^{23} per mole

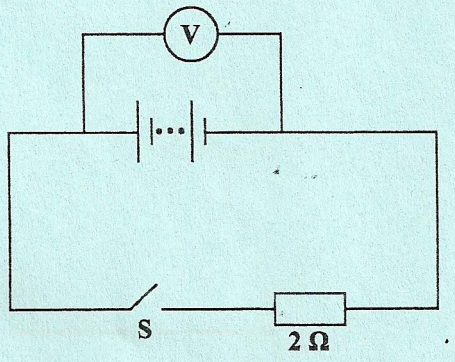
1. In the equation for the current through a conductor $I = nev\,A$, v represents the

(A) voltage
(B) terminal p.d.
(C) volume
(D) velocity

2. The correct unit for resistivity is

(A) Ω m
(B) m Ω^{-1}
(C) Ω m^{-1}
(D) Ω m^{-2}

3. The diagram below shows a battery connected in series with a 2 ohm resistor and a switch S. A voltmeter connected across the battery reads 6 V when S is opened and 4 V when S is closed.



What is the internal resistance of the battery?

(A) 0.3 Ω
(B) 1.0 Ω
(C) 2.0 Ω
(D) 3.0 Ω

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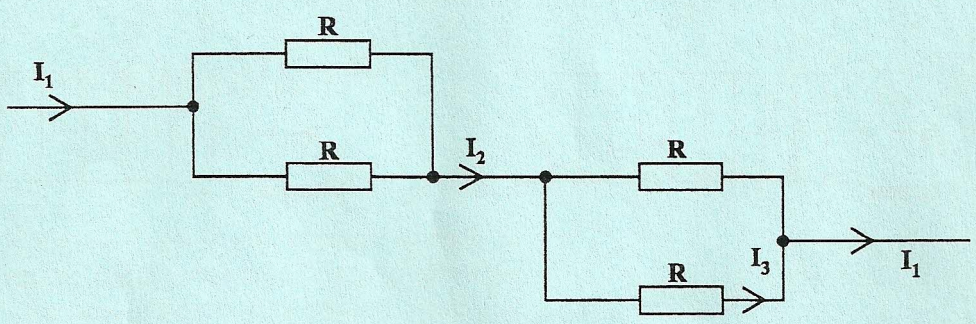
4. Four identical resistors are arranged as shown in the diagram below.



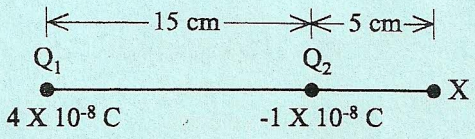
What is the current ratio $I_1 : I_2 : I_3$?

(A) 1 : 1 : 1
(B) 1 : 1 : 2
(C) 2 : 2 : 1
(D) 3 : 2 : 1

5. In SI, the unit of electric field is

(A) $N\ A^{-1}$
(B) $N\ C^{-1}$
(C) $C\ m^{-1}$
(D) $J\ m^{-1}$

6. What is the electric potential of point X in the diagram below?



(A) 0 volts
(B) 800 volts
(C) 1 600 volts
(D) 2 700 volts

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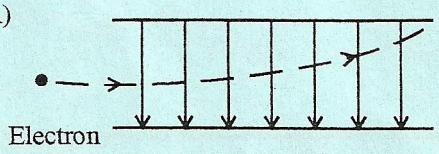
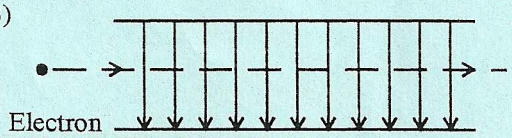
7. Which of the following shows the possible path of a high speed electron through a uniform electric field?

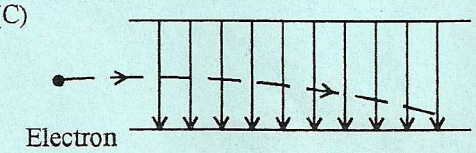
(A)



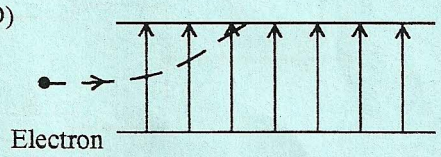
(B)



(C)



(D)



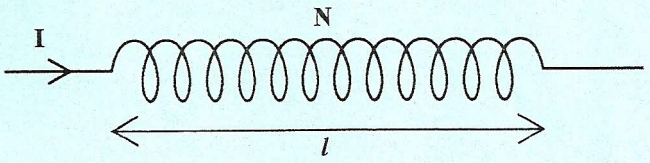
8. A capacitor of capacitance 100 μF is fully charged by a 200 V battery. How much energy is stored by the capacitor?

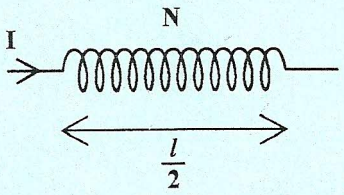
(A) 2 mJ
(B) 2 J
(C) 4 J
(D) 10 mJ

9. 1 farad is equivalent to

(A) $1\ JC^{-1}$
(B) $1\ NC^{-1}$
(C) $1\ CV^{-1}$
(D) $1\ VC^{-1}$

Item **10** refers to the diagram below which shows a long air coil solenoid carrying a current, *I*, with a flux density of 40 μT along its centre line.



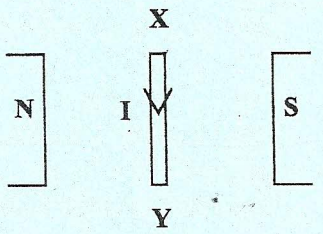


10. If the solenoid is compressed so that its length, *l*, is reduced to half its original value, what would be the flux density along the centre line?

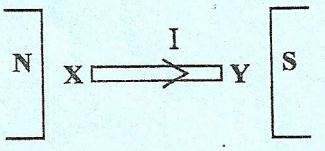
(A) 20 μT
(B) 80 μT
(C) 120 μT
(D) 160 μT

11. Consider a current-carrying conductor, *XY*, placed between the poles of a magnet as shown below. In which orientation would the wire experience the greater force?

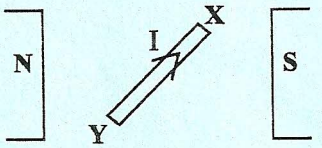
(A)



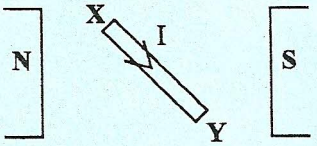
(B)



(C)



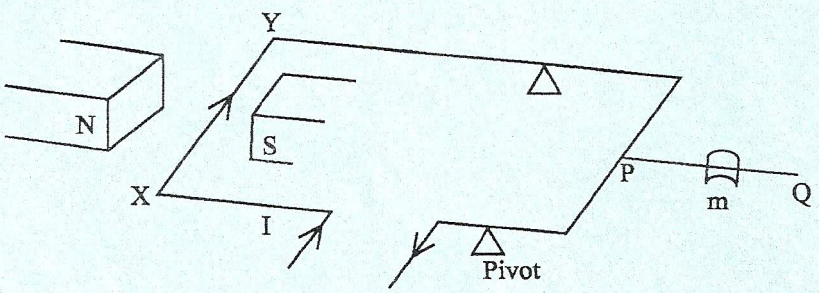
(D)



12. A road is 15 m below a transmission line which carries an alternating current of peak value 100 A. The magnitude of the magnetic flux density at the road (due to the current in the transmission line) is

(A) 1.18×10^{-2} T
(B) 1.26×10^{-4} T
(C) 1.33×10^{-6} T
(D) 4.19×10^{-6} T

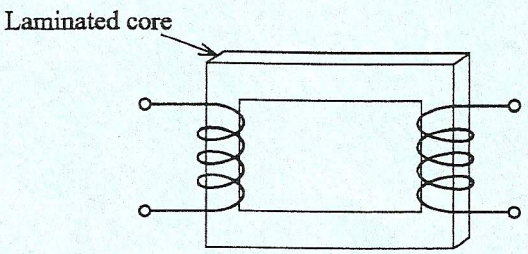
Item 13 refers to the diagram below which shows a rectangular coil, resting on points. Part of the coil is between North and South poles of magnets, as shown. A small mass, m, rests on the shaft PQ. The coil is in equilibrium when no current flows.



13. When a current flows from X to Y, what could be done to restore balance?

(A) Reverse the direction of the current
(B) Move **m** towards **P**
(C) Move **m** towards **Q**
(D) Increase mass of **m**

Item 14 refers to the following diagram.

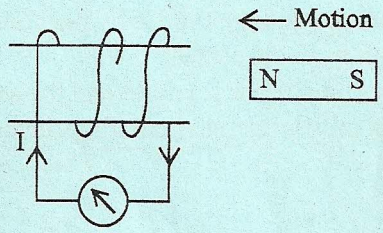


14. The iron core of a transformer is laminated because

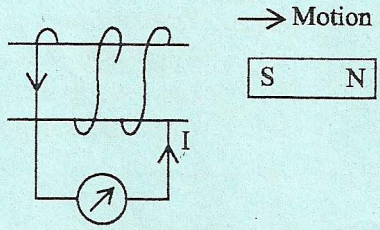
(A) it can be more easily magnitized and demagnitized
(B) it increases the magnetic flux of the core
(C) it increases the surface area and the induced e.m.f
(D) it minimizes the circulation of induced currents

15. The diagrams below show a bar magnet being inserted or withdrawn from a solenoid. In which diagram is the current flow correct?

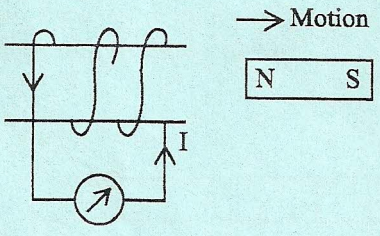
(A)



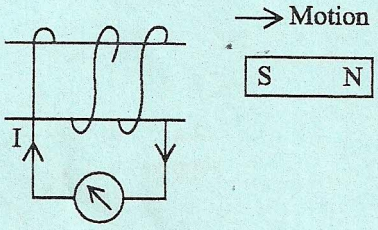
(C)



(B)



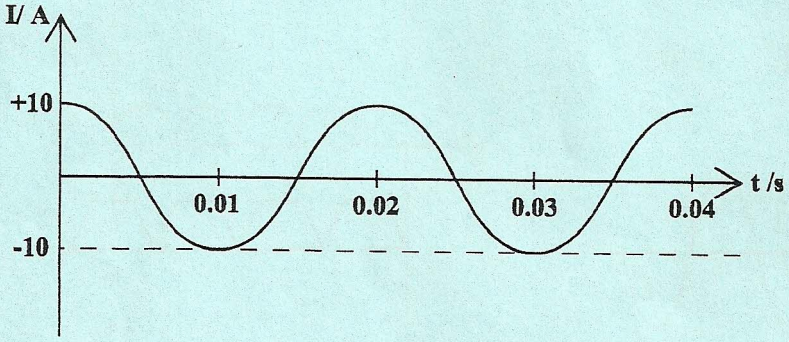
(D)



16. The effective value of a sinusoidal alternating curve with a peak current, I_0, is

(A) $2\ I_0$
(B) $1.41\ I_0$
(C) $0.50\ I_0$
(D) $0.707\ I_0$

Item 17 refers to the following graph which represents a sinusoidal alternating current against time.



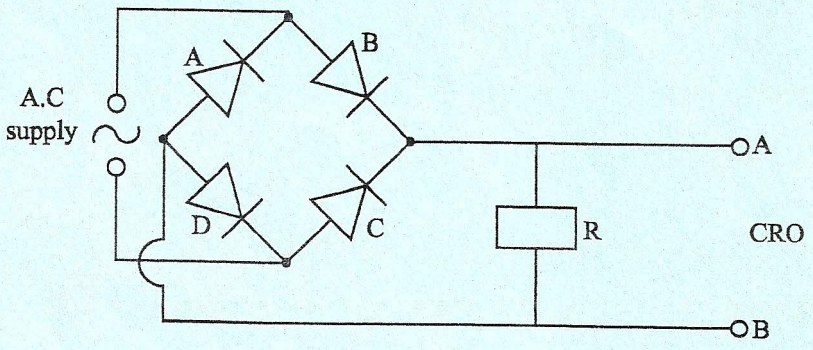
17. The equation to represent this alternating current is

(A) $I = 10 \cos\ 50\ \pi t$
(B) $I = 10 \cos\ 80\ \pi t$
(C) $I = 10 \cos 100\ \pi t$
(D) $I = 20 \cos 200\ \pi t$

18. Why is it advantageous to use an alternating current instead of a steady d.c. when transmitting electrical energy at high voltages?

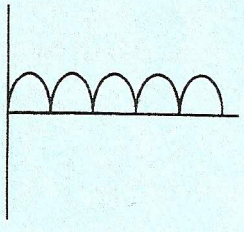
(A) Transformers can be used to step down the voltage for use by the consumer.
(B) There is less electro-magnetic radiation from the cables.
(C) Less energy is lost with the a.c. of a particular r.m.s. value than the same value of d.c.
(D) Appliances in houses and factories can only work on alternating current.

Item **19** refers to the following diagram.

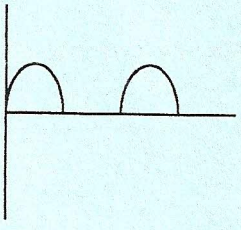


19. Which ONE of the following traces will be seen on the cathode ray oscilloscope connected across *AB* if diode *B* is defective and does NOT conduct in any direction?

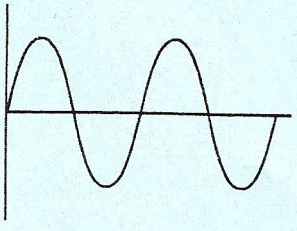
(A)



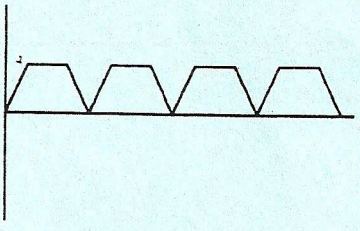
(C)



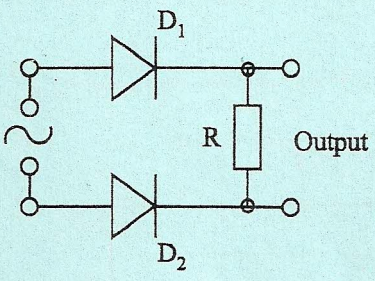
(B)



(D)

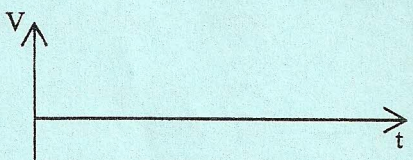


Item **20** refers to the following diagram.

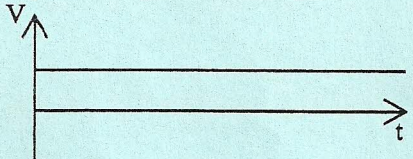


20. Which of the graphs below describes the output of the circuit shown above?

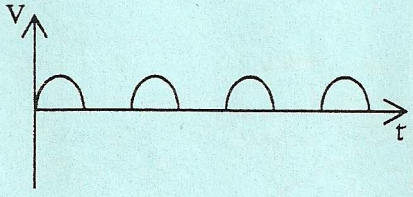
(A)



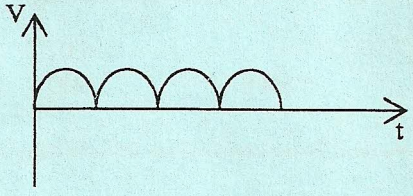
(B)



(C)

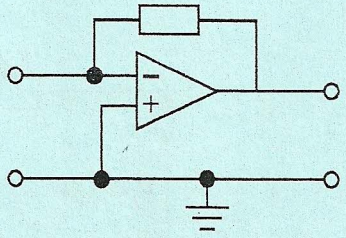


(D)

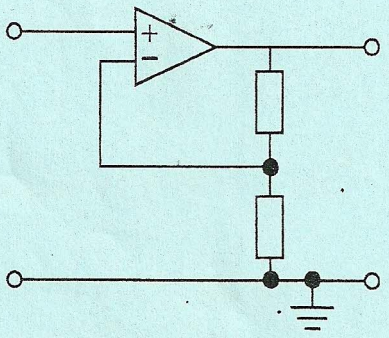


21. Which one of the circuits below is NOT a non-inverting amplifier?

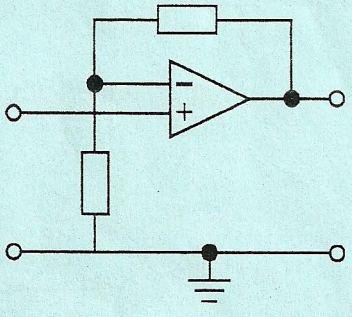
(A)



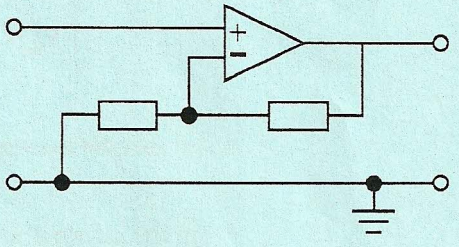
(B)



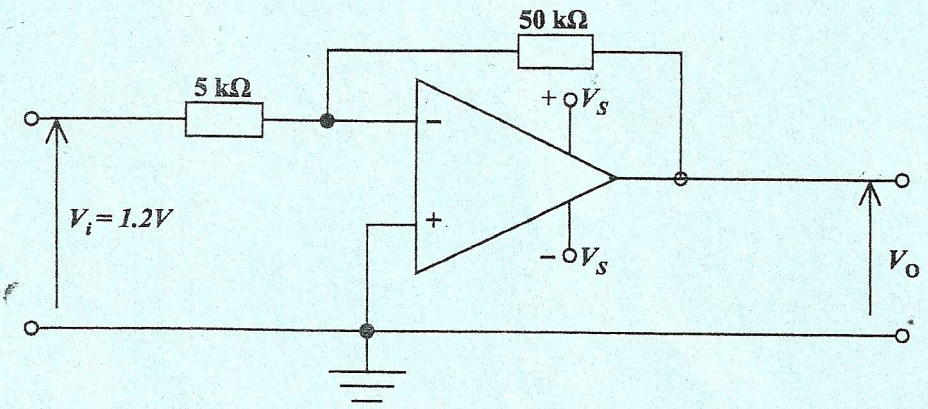
(C)



(D)



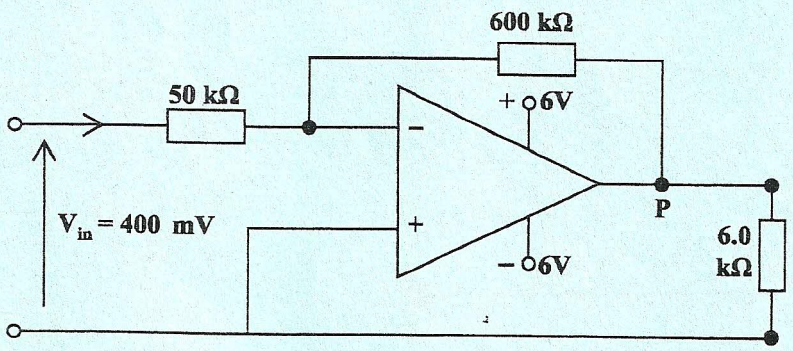
Item **22** refers to the following diagram which shows an amplifier.



22. If $V_s = \pm 9$V what is the value of V_o?

(A) −12 V
(B) − 9 V
(C) 10 V
(D) 13 V

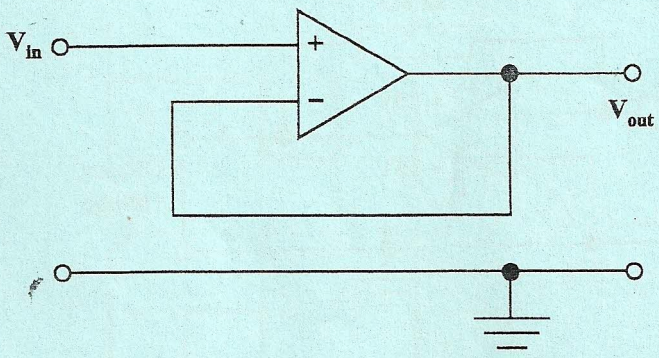
Item **23** refers to the following diagram.



23. From the information given in the operational amplifier circuit above, determine the current in the 6.0 kΩ load resistor.

(A) 0.6 mA
(B) 0.8 mA
(C) 1.0 mA
(D) 6.7 mA

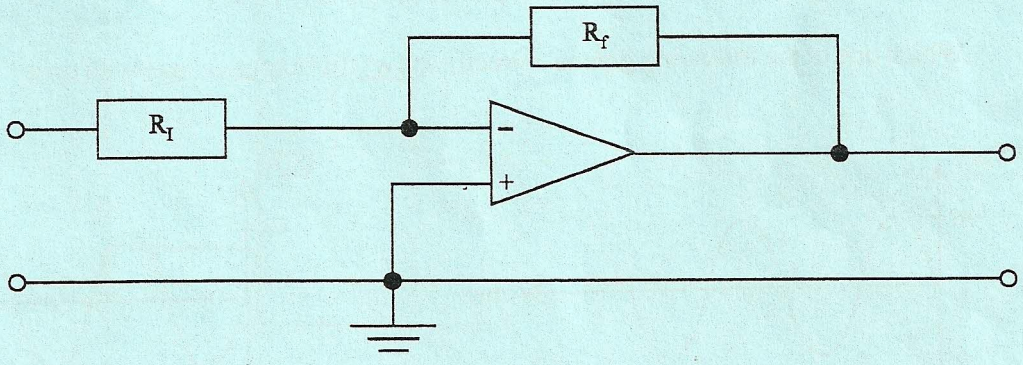
Item **24** refers to the following diagram.



24. The circuit above represents

(A) a voltage follower
(B) a summing amplifier
(C) an inverting amplifier
(D) a non-inverting amplifier

Item **25** refers to the following diagram.



25. In the operational amplifier circuit shown above, the feedback resistor (R_f) serves to

(A) make the amplifier non-inverting
(B) increase output impedance
(C) decrease the bandwidth
(D) decrease the gain

Item 26 refers to the following diagrams.

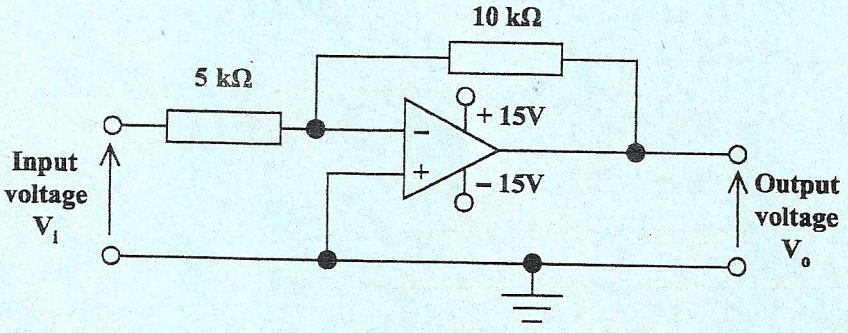


Figure 1

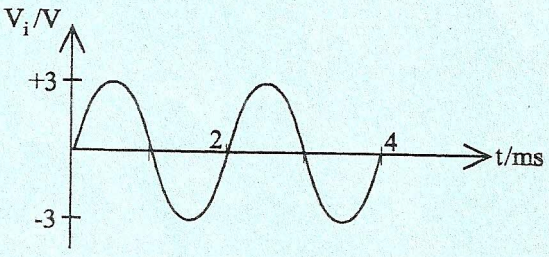
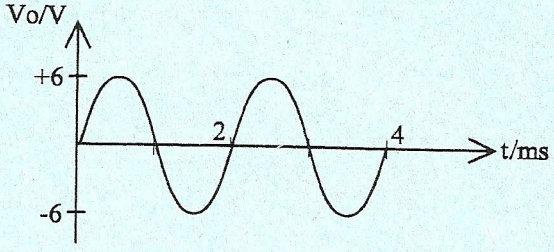


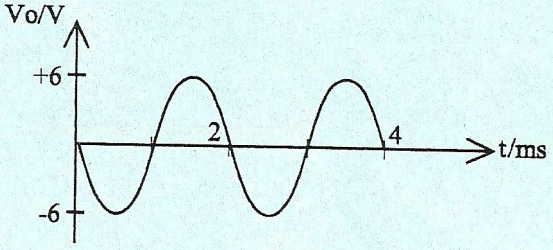
Figure 2

26. The sinusoidal alternating voltage shown in Figure 2 is applied to the input of the operational amplifier shown in Figure 1. The voltage of the power supply is ± 15 V.

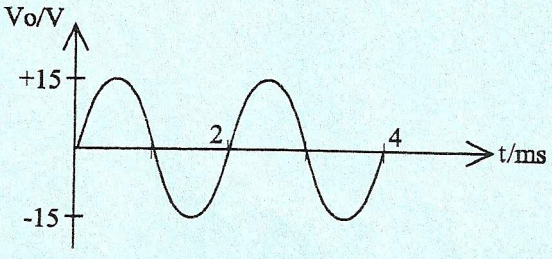
Which one of the following graphs correctly shows the output voltage with time?



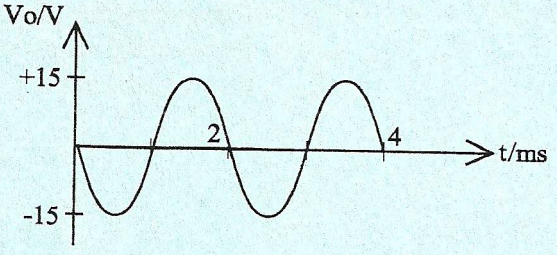
(A)



(B)

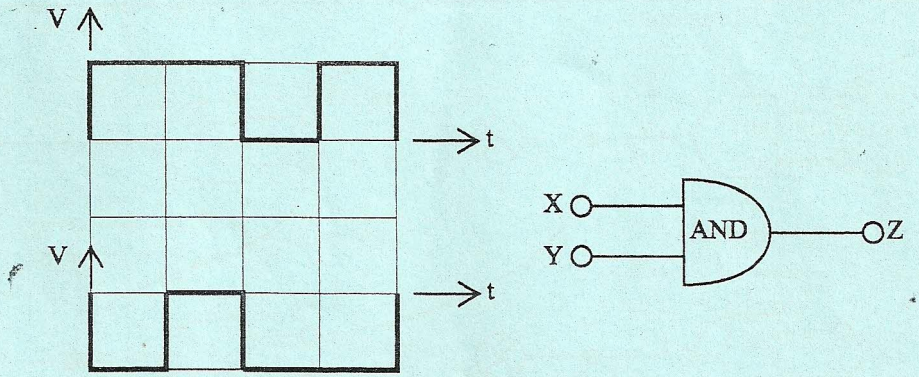


(C)



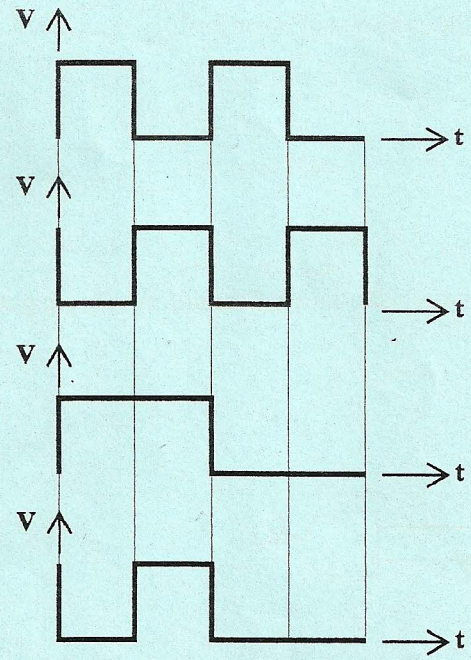
(D)

27. Two four-bit binary numbers are fed into the inputs, X and Y, on an AND gate. The numbers are represented by the pulse trains in the V-t diagrams shown below.



Which ONE of the following pulse trains represents the output pulse from the AND gate?

(A)

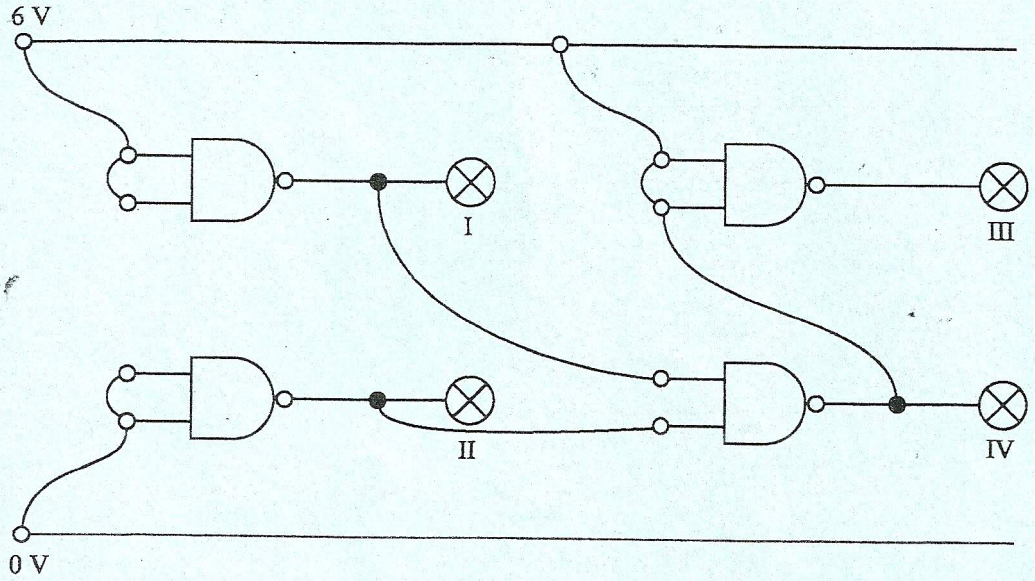


(B)

(C)

(D)

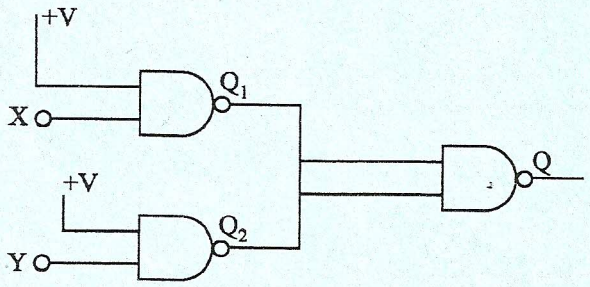
Item 28 refers to the following diagram which shows a quad-NAND circuit board connected to a 6 supply. It has an indicator diode connected to each output. The diodes are ON if the output is a logic 1.



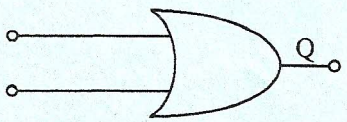
28. If wires are connected as shown which indicators will be on?

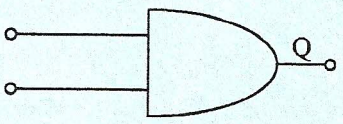
(A) I and III
(B) I and IV
(C) II and III
(D) II and IV

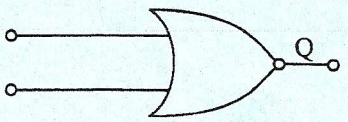
Item 29 refers to the following diagram which shows a combination of logic gates.

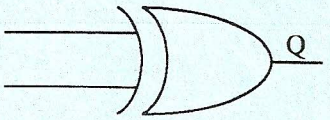


29. What single logic gate could replace this circuit?

(A)


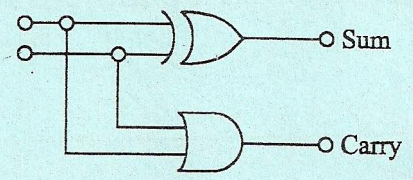
(C)


(B)


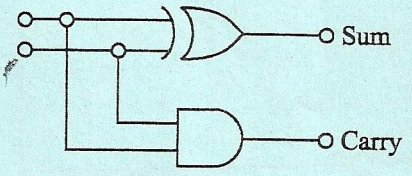
(D)


30. Which is the correct circuit for a half-adder?

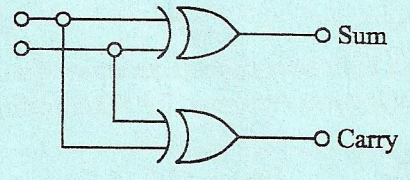
(A)



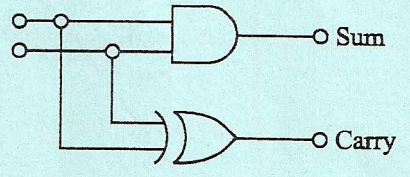
(B)



(C)



(D)



31. Light falls on a photoelectric material and no electrons are emitted. Electrons may be emitted if which of the following is/are increased?

I. The intensity of the light
II. The frequency of the light
III. The wavelength of the light

(A) I only
(B) II only
(C) III only
(D) I and III only

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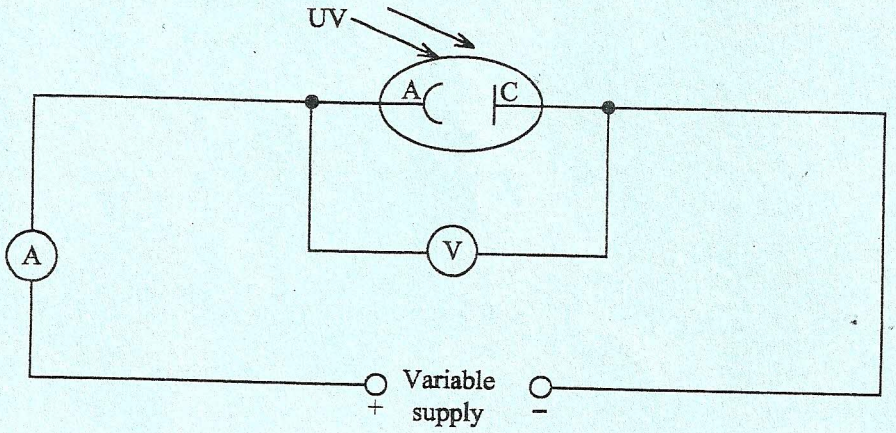
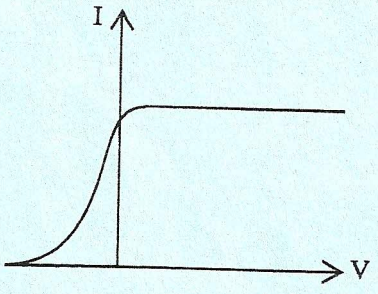
Item 32 refers to the diagram below which shows a photocell, consisting of an anode A and a cathode C inside an evacuated glass tube, connected to an ammeter, voltmeter and a variable d.c. power supply.

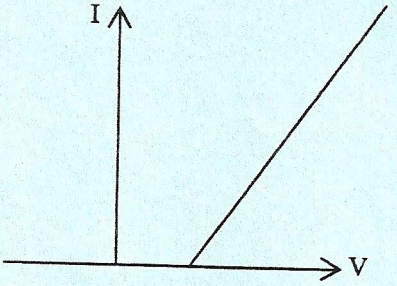


32. When the photocell is illuminated with ultra violet light and photoelectrons are emitted corresponding current and voltage values are plotted. Which graph correctly shows the relationship between I and V?

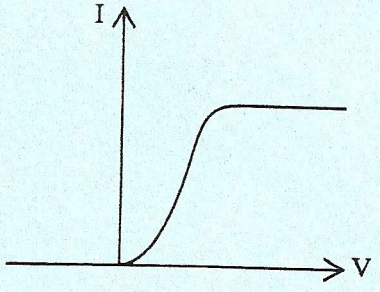
(A)



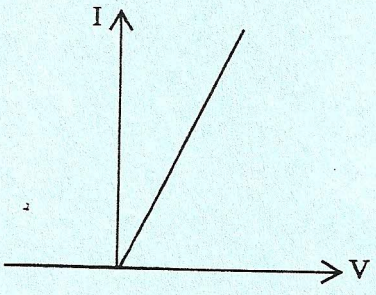
(C)



(B)



(D)



33. A metal surface has a work function of 3.8 eV. The threshold wavelength for this metal is

(A) 6.08×10^{-19} m
(B) 1.09×10^{-15} m
(C) 3.27×10^{-7} m
(D) 9.17×10^{14} m

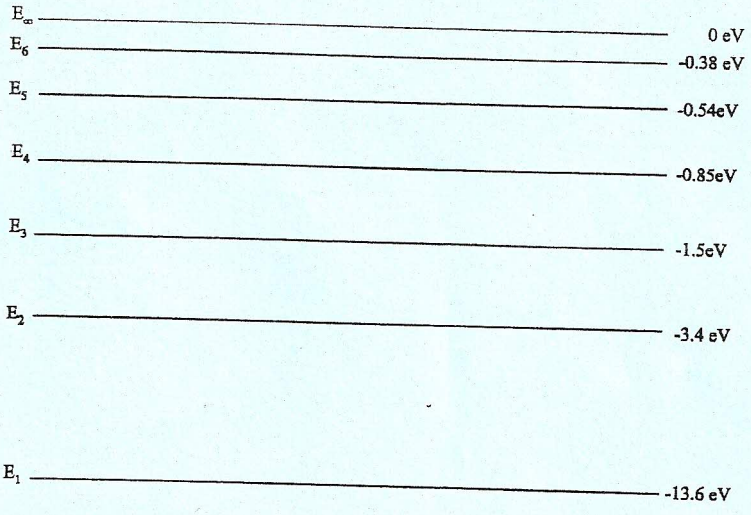
34. The intensity of X-rays passing through a material of thickness, x, is given by

$$I = I_0 \exp(-\mu x).$$

What does the symbol "μ" in the equation represent?

(A) The time constant of the X-rays
(B) The permittivity of the material
(C) The permeability of the material
(D) The linear absorption coefficient of the material

Item **35** refers to the drawing below which shows an energy level diagram for hydrogen.



35. What is the energy required to ionize a hydrogen atom in its ground state?

(A) 0.38 eV
(B) 10.2 eV
(C) 13.6 eV
(D) 20.3 eV

---

36. Which of the following demonstrates the particle nature of electromagnetic radiation?

(A) β-decay of nuclei and electron diffraction
(B) Photoelectric effect and absorption spectra
(C) Interference and polarisation
(D) Emission spectra and reflection

37. Which TWO scientists conducted an experiment which proves that the nucleus of an atom is very small and positively charged?

(A) Davisson and Germier
(B) Bohr and Rutherford
(C) Mosley and Einstein
(D) Geiger and Marsden

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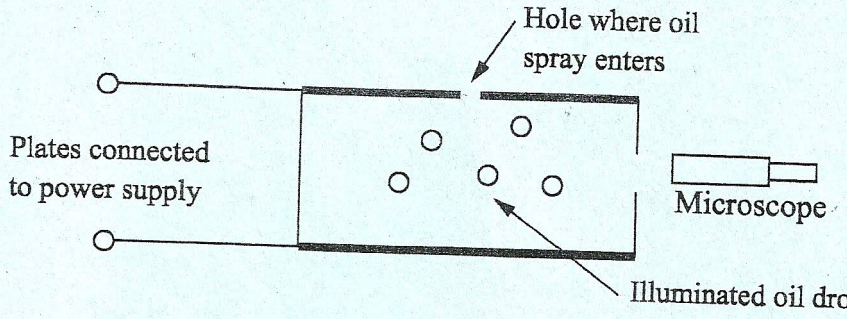
Item **38** is about Millikan's oil drop experiment which is depicted in the diagram below.



38. Which statement about the behaviour of the oil drops during the experiment is correct?

(A) When an oil drop becomes charged, the size of the charge must equal *e*.
(B) When an oil drop is stationary, it must carry a charge.
(C) When an oil drop moves upwards, only the electric force is acting on it.
(D) When no electric field acts, all drops move downwards with the same constant velocity.

---

39. The equation shows the disintegration of Polonium –210 to a stable isotope of lead.

$$^{210}_{84}Po \longrightarrow {}^{206}_{82}Pb + {}^{4}_{2}He + \Delta Q$$

For the above equation:

mass of $^{206}_{82}Pb = 205.969\ \mu$

mass of $^{4}_{2}He = 4.004\ \mu$

mass of $^{210}_{84}Po = 209.982\ \mu$

What is the mass equivalent of ΔQ?

(A) 1.5×10^{-29} kg
(B) 6.7×10^{-27} kg
(C) 3.5×10^{-25} kg
(D) 3.4×10^{-25} kg

40. Which of the following statements about the nucleus is TRUE?

(A) The mass of a nucleus is less than the total mass of its separate consistent nucleons
(B) The mass of a nucleus is greater than the total mass of its separate consistent nucleons
(C) The binding energy per nucleon of atoms is constant as atomic mass is increased
(D) The binding energy per nucleon increases as the atomic mass of the atom increases

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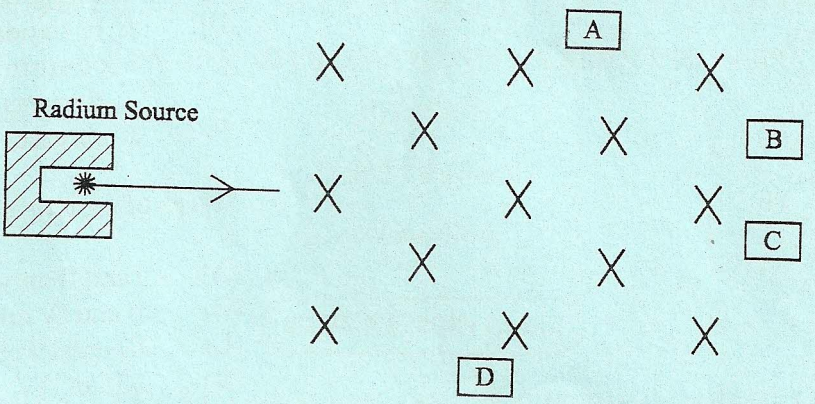
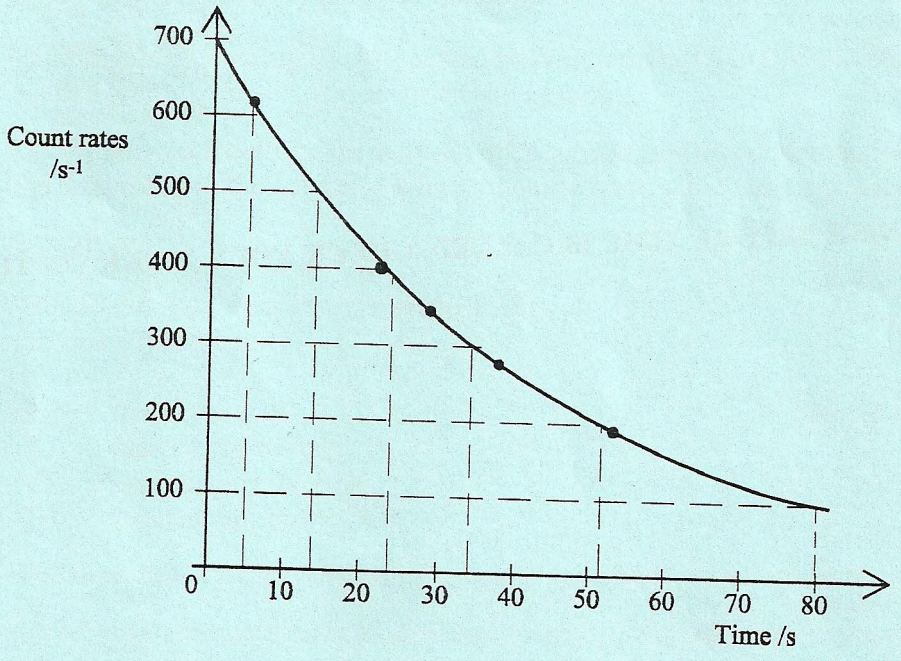
41. A radium source is placed in a magnetic field as shown below. The field acts into the page. At what position would a β-particle be detected?



Item 42 refers to the following diagram which shows how the count rate of a certain sample of radioactive material varies with time.



42. What is the approximate half-life of the sample?

(A) 25 s
(B) 35 s
(C) 40 s
(D) 50 s

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43. Radioactive lead $^{211}_{82}Pb$ decays by two beta particles and one alpha particle. What is the resulting nuclide?

(A) $^{203}_{82}Pb$

(B) $^{207}_{82}Pb$

(C) $^{211}_{84}Pb$

(D) $^{207}_{84}Pb$

44. The following statements refer to radioactive decay.

I. It is a random process
II. It is a spontaneous process
III. It is dependent on the chemical combination of radioactive elements
IV. It increases with temperature

Which of the above statements are TRUE?

(A) I and II only
(B) II and IV only
(C) III and IV only
(D) I, II and IV only

45. The half-life of a sample of radioactive substance is 100 years. What is its decay constant?

(A) 6.93×10^{-3} year^{-1}
(B) 5.00×10^{1} year^{-1}
(C) 6.93×10^{1} year^{-1}
(D) 1.44×10^{2} year^{-1}

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.