

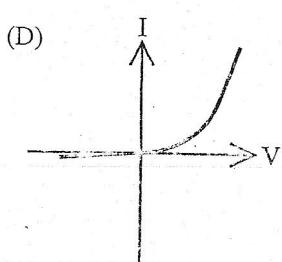
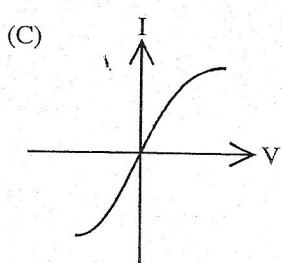
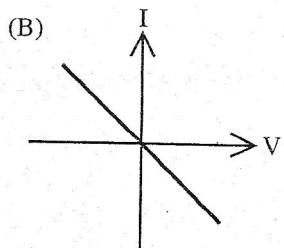
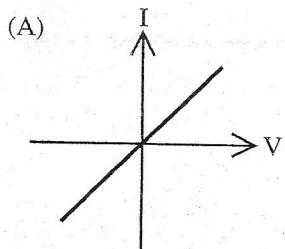
## LIST OF PHYSICAL CONSTANTS

Speed of light in free space	c	=	$3.00 \times 10^8 \text{ m s}^{-1}$
Permeability of free space	$\mu_0$	=	$4\pi \times 10^{-7} \text{ H m}^{-1}$
Permittivity of free space	$\epsilon_0$	=	$8.85 \times 10^{-12} \text{ F m}^{-1}$
Elementary charge	e	=	$1.60 \times 10^{-19} \text{ C}$
The Planck constant	h	=	$6.63 \times 10^{-34} \text{ J s}$
Unified atomic mass constant	u	=	$1.66 \times 10^{-27} \text{ kg}$
[1u is equivalent to 931 Me V]			
Rest mass of electron	$m_e$	=	$9.11 \times 10^{-31} \text{ kg}$
Rest mass of proton	$m_p$	=	$1.67 \times 10^{-27} \text{ kg}$
Acceleration due to gravity	g	=	$9.81 \text{ m s}^{-2}$
1 Atmosphere	Atm	=	$1.00 \times 10^5 \text{ N m}^{-2}$
Avogadro's number	$N_A$	=	$6.02 \times 10^{23} \text{ per mole}$

1. When a potential difference of 2 V is applied across a resistor, 10 J of energy are converted to thermal energy. What charge flows through the resistor?

(A) 0.2 C  
(B) 5 C  
(C) 12 C  
(D) 20 C

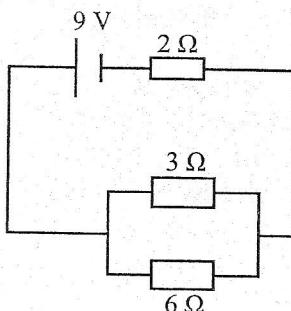
2. Which of the following graphs shows the I - V characteristic of a filament lamp?



3. Given that a wire of length, L, and area, A, has resistance R, what is the resistance of a wire of similar material which is twice as long and half the diameter?

(A)  $\frac{1}{4}R$   
(B)  $2R$   
(C)  $4R$   
(D)  $8R$

4. For the circuit diagram below, determine the current flowing through the  $6\Omega$  resistor.



(A) 0.75 A  
(B) 0.82 A  
(C) 1.0 A  
(D) 1.5 A

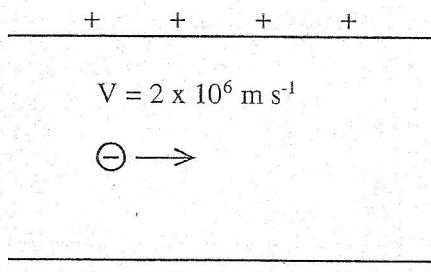
5. A capacitor of capacitance  $100 \mu F$  is fully charged by a 200 V battery. How much energy is stored by the capacitor?

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

6. The work done per unit charge in bringing a small positive charge from infinity to a point is the definition of

(A) potential energy  
(B) potential  
(C) electric field strength  
(D) potential gradient

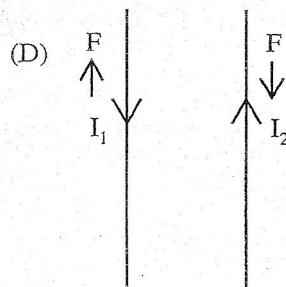
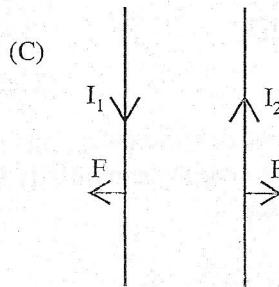
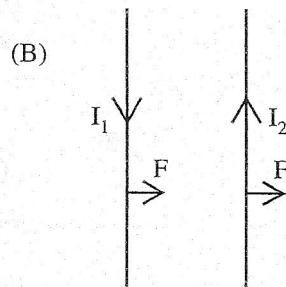
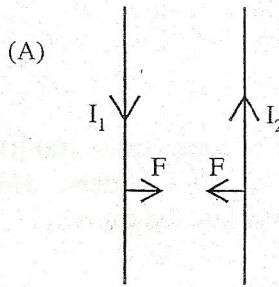
Item 7 refers to the following diagram.



7. What is the force exerted on the electron shown travelling between two parallel plates with a potential difference of 800 V and plate separation of 0.05 m?

- (A)  $6.4 \times 10^{-18} \text{ N}$   
(B)  $2.56 \times 10^{-15} \text{ N}$   
(C) 40 N  
(D)  $1.6 \times 10^4 \text{ N}$

9. Which of the following diagrams shows the correct direction of the forces on two wires carrying current in opposite directions?



8. In the equation for the current through a conductor  $I = nevA$ ,  $v$  represents the

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

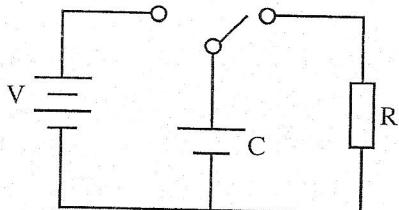
10. The SI unit of magnetic flux is the

- (A) gauss
- (B) oersted
- (C) tesla
- (D) weber

11. A current-carrying conductor of mass  $2 \times 10^{-2}$  kg carrying a current of 2.0 A is balanced in a magnetic field. If the length of the conductor is 8 cm, determine the magnetic field strength required.

- (A)  $1.25 \times 10^{-5}$  T
- (B)  $1.25 \times 10^{-4}$  T
- (C)  $1.25 \times 10^{-1}$  T
- (D) 1.25 T

Item 12 refers to the following diagram.



12. The capacitor in the circuit above has capacitance, C. It is charged to a voltage, V, and then discharged through a resistor with resistance, R. The charge at any time, t, is given by

- (A)  $Q = \frac{C}{V} e^{\frac{-t}{RC}}$
- (B)  $Q = \frac{V}{C} e^{\frac{t}{RC}}$
- (C)  $Q = CVe^{\frac{-t}{RC}}$
- (D)  $Q = CVe^{\frac{-t}{RC}}$

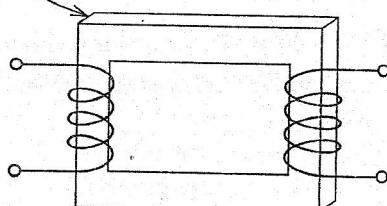
13.

Item 13 refers to the following diagram which shows a square with vertices P, Q, R, S. Two long wires at vertices Q and S carry the same current, I, perpendicular to the plane of the paper, in the directions indicated. Determine the direction of the resultant magnetic field at vertex R.

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Item 14 refers to the following diagram.

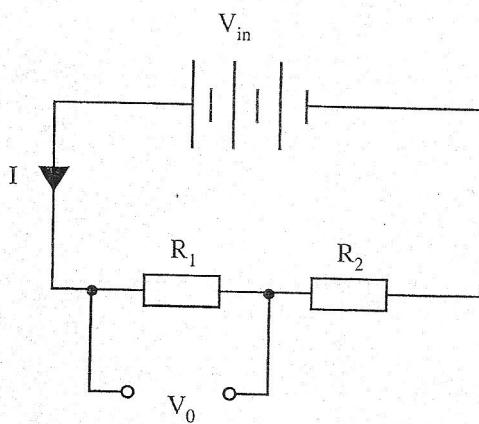
Laminated core



The iron core of a transformer is laminated because

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

**Item 15** refers to the following diagram.



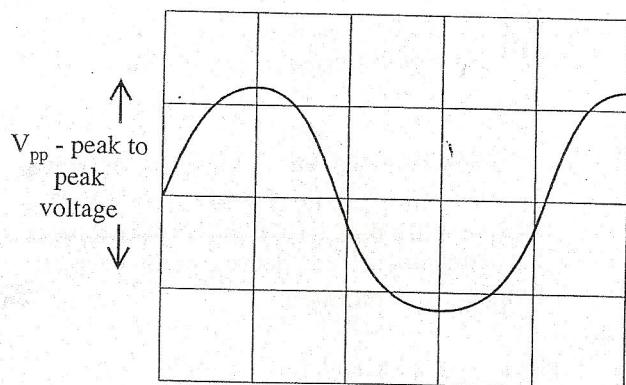
- 15.** The device above represents a potential divider. The expression used to determine the output voltage is

- (A)  $V_o = I(R_1 + R_2)$
- (B)  $V_o = V_{in} \left( \frac{R_1 + R_2}{R_1} \right)$
- (C)  $V_o = V_{in} \left( \frac{R_1}{R_1 + R_2} \right)$
- (D)  $V_o = I(R_1 + R_2)$

- 16.** With which of the following devices is the depletion layer associated?

- (A) Transformer
- (B) Capacitor
- (C) Semi-conductor diode
- (D) Operational amplifier

**Item 17** refers to the following diagram.



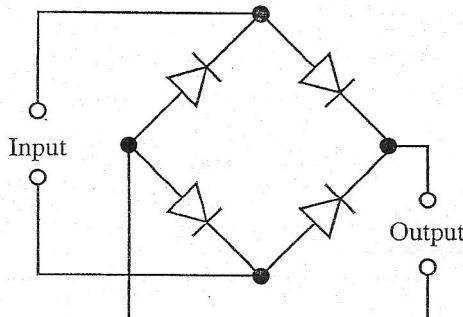
- 17.** The r.m.s value of a.c voltage is related to the peak to peak voltage by the equation

- (A)  $V_{rms} = \frac{V_{pp}}{\sqrt{2}}$
- (B)  $V_{rms} = \frac{V_{pp}}{2\sqrt{2}}$
- (C)  $V_{rms} = \sqrt{2} V_{pp}$
- (D)  $V_{rms} = \frac{V_{pp}}{2}$

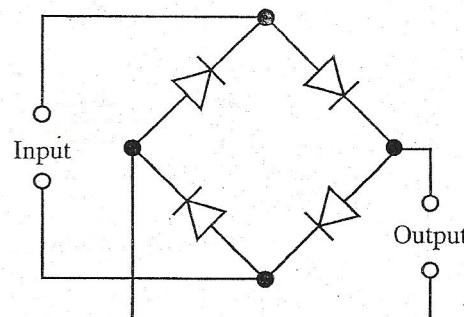
- 18.** A sinusoidal alternating current of peak value 50A dissipates power ( $P$ ) in a  $2\Omega$  resistor. What is the value of  $P$ ?

- (A) 1 250 W
- (B) 2 500 W
- (C) 5 000 W
- (D) 10 000 W

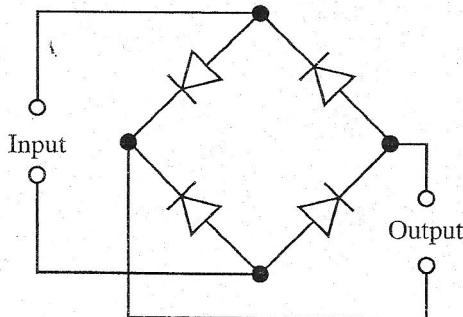
19. Which one of the following diagrams shows the correct arrangement for a full wave rectifier circuit?



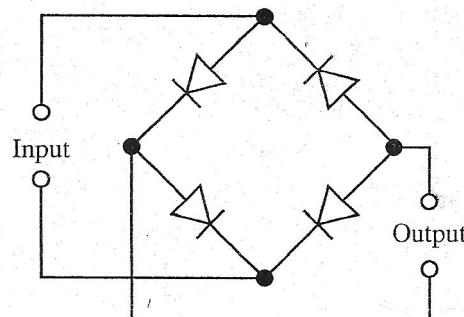
(A)



(B)



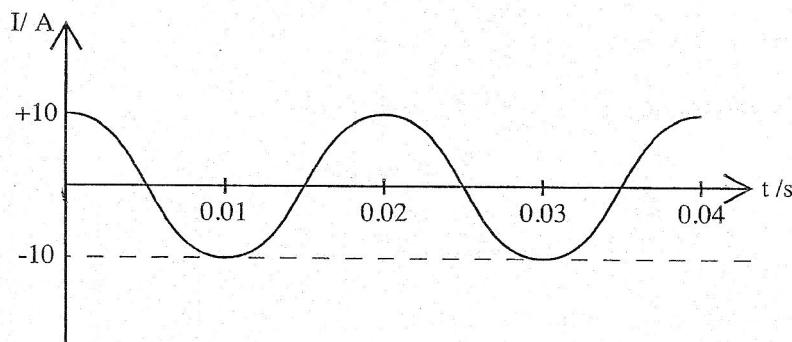
(C)



(D)

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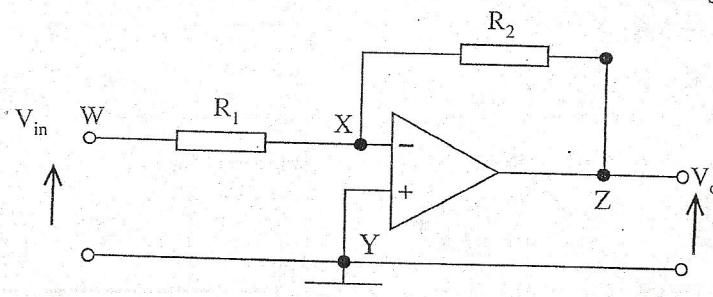
Item 20 refers to the following graph which represents a sinusoidal alternating current against time as drawn below.



20. The equation to represent this alternating current is

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

Items 21 and 22 refer to the following diagram of an inverting amplifier.



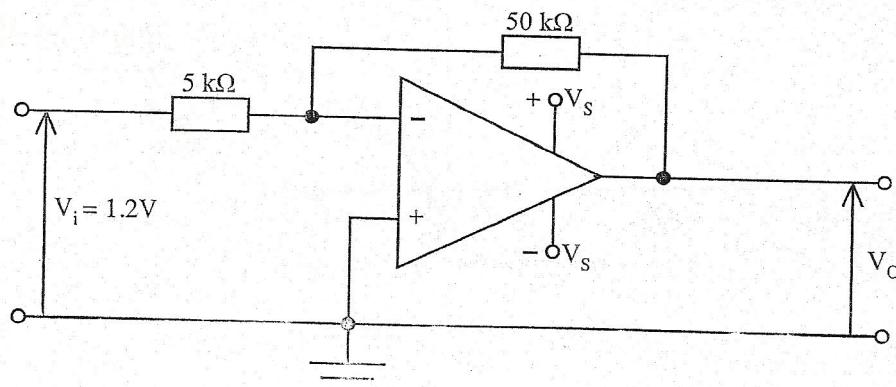
21. Which of the labelled points could be called a virtual earth?

- (A) X only
- (B) Z only
- (C) X and Y
- (D) W and Y

22. What is the output,  $V_o$ , of the amplifier?

- (A)  $\left( \frac{R_1 + R_2}{R_1} \right) V_{in}$
- (B)  $- \frac{R_2}{R_1} V_{in}$
- (C)  $\frac{R_2 + R_1}{R_1} V_{in}$
- (D)  $- \frac{R_1}{R_2} V_{in}$

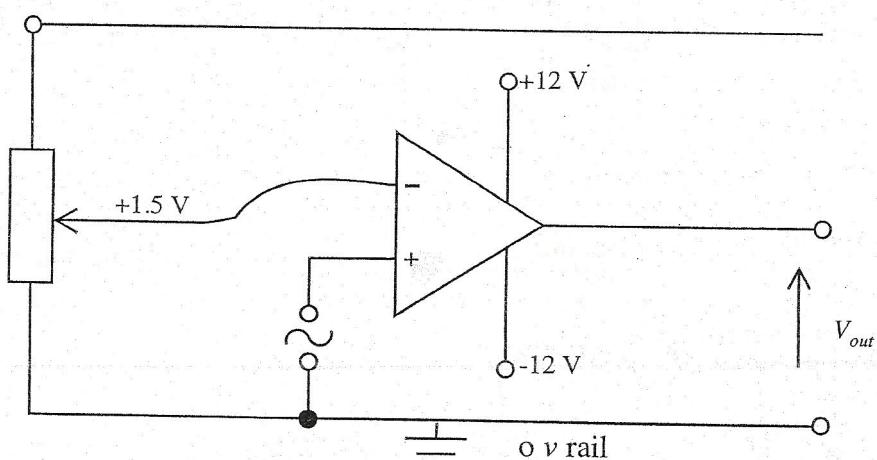
Item 23 refers to the following diagram which shows an amplifier.



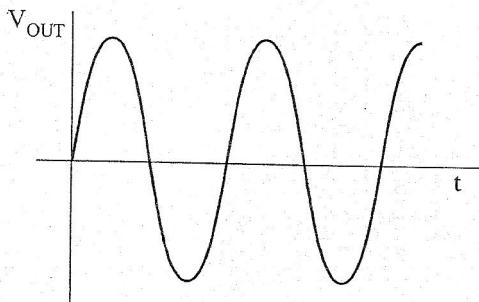
23. If  $V_s = \pm 9V$  what is the value of  $V_o$ ?

- (A) -9V
- (B) 10V
- (C) 13V
- (D) -12V

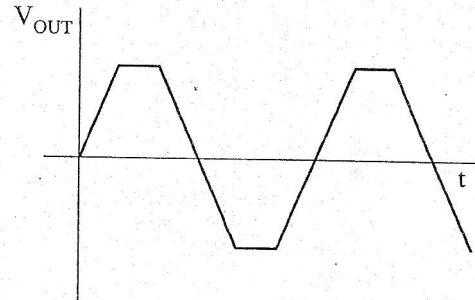
Item 24 refers to the following diagram. In the circuit shown an a.c. signal with an amplitude of 3 V is applied to the non-inverting terminal of the op. amp. By means of the potential divider the potential at the inverting terminal is set at +1.5 V.



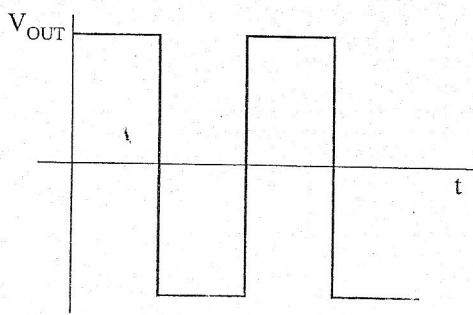
24. Which sketch graph shows the form of the output?



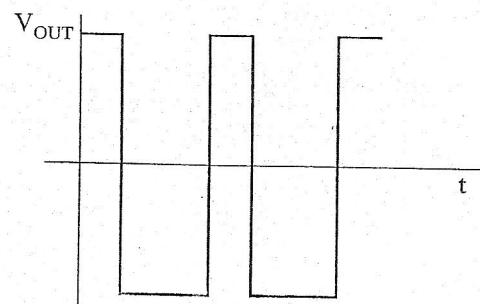
(A)



(B)

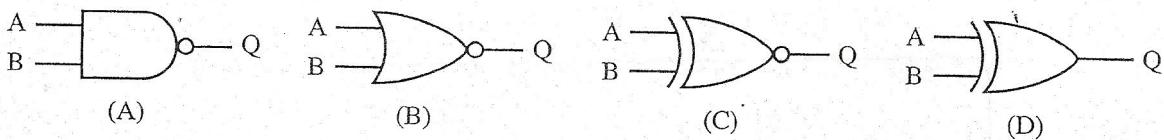


(C)



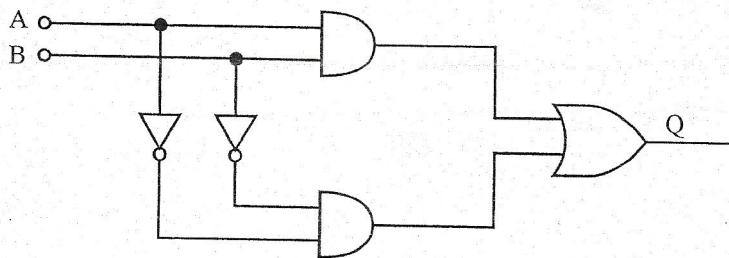
(D)

25. Which symbol below represents an X-NOR logic gate?



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Item 26 refers to the following diagram.



26. Which is the correct truth table for the circuit above?

(A)

A	B	Q
1	1	0
1	0	1
0	1	1
0	0	0

(B)

A	B	Q
1	1	1
1	0	0
0	1	0
0	0	0

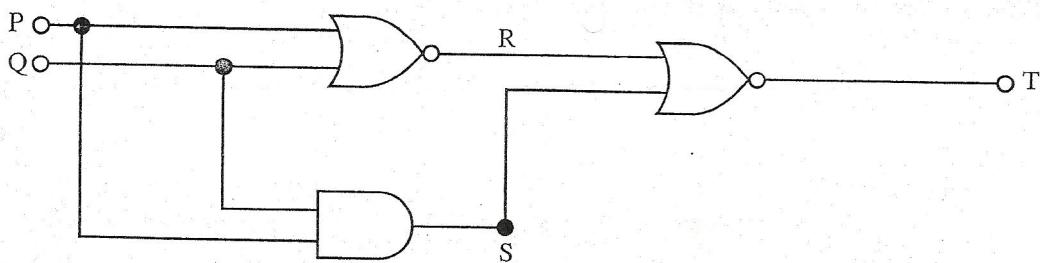
(C)

A	B	Q
1	1	1
1	0	1
0	1	1
0	0	0

(D)

A	B	Q
1	1	1
1	0	0
0	1	0
0	0	1

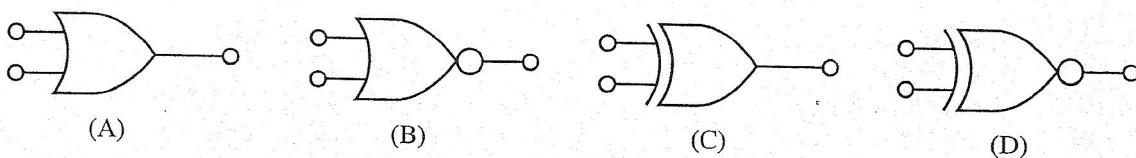
Items 27 - 28 refer to the following diagram.



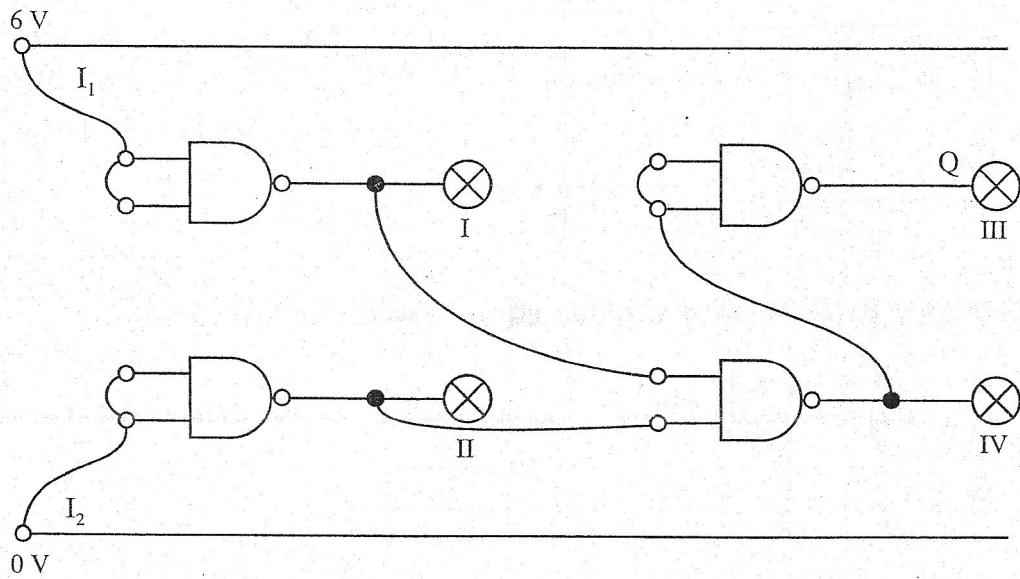
27. If the inputs to P and Q are both held at logic 1 then the states of R, S and T are

	R	S	T
(A)	1	1	1
(B)	1	0	0
(C)	0	1	0
(D)	0	1	1

28. The symbol for the logic gate which has the equivalent action to this complete circuit is



Items 29 - 30 refer to the following diagram which shows a quad-NAND circuit board connected to a 6V supply. It has an indicator diode connected to each output.



29. 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

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30. With inputs  $I_1$  and  $I_2$  and output Q, the whole circuit could be replaced by

(A) an OR gate  
 (B) a NOR gate  
 (C) an EXOR gate  
 (D) an AND gate

31. Which of the following gives the correct equation for the energy (E) of a photon?

(A)  $E = \frac{h}{f}$   
 (B)  $E = \frac{hf}{2}$   
 (C)  $E = \frac{hc}{\lambda}$   
 (D)  $E = \frac{c\lambda}{h}$

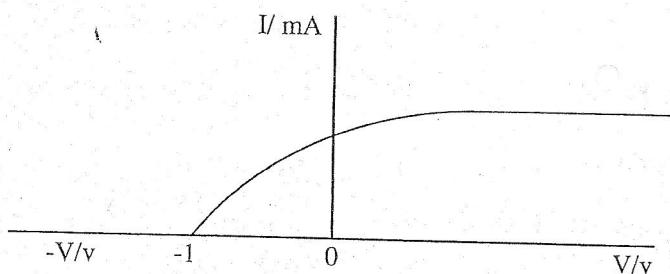
32. An electron has kinetic energy of  $8 \times 10^{-18}$  J. What is this value in electron-volts?

(A) 0.5 eV  
 (B) 4 eV  
 (C) 50 eV  
 (D) 80 eV

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

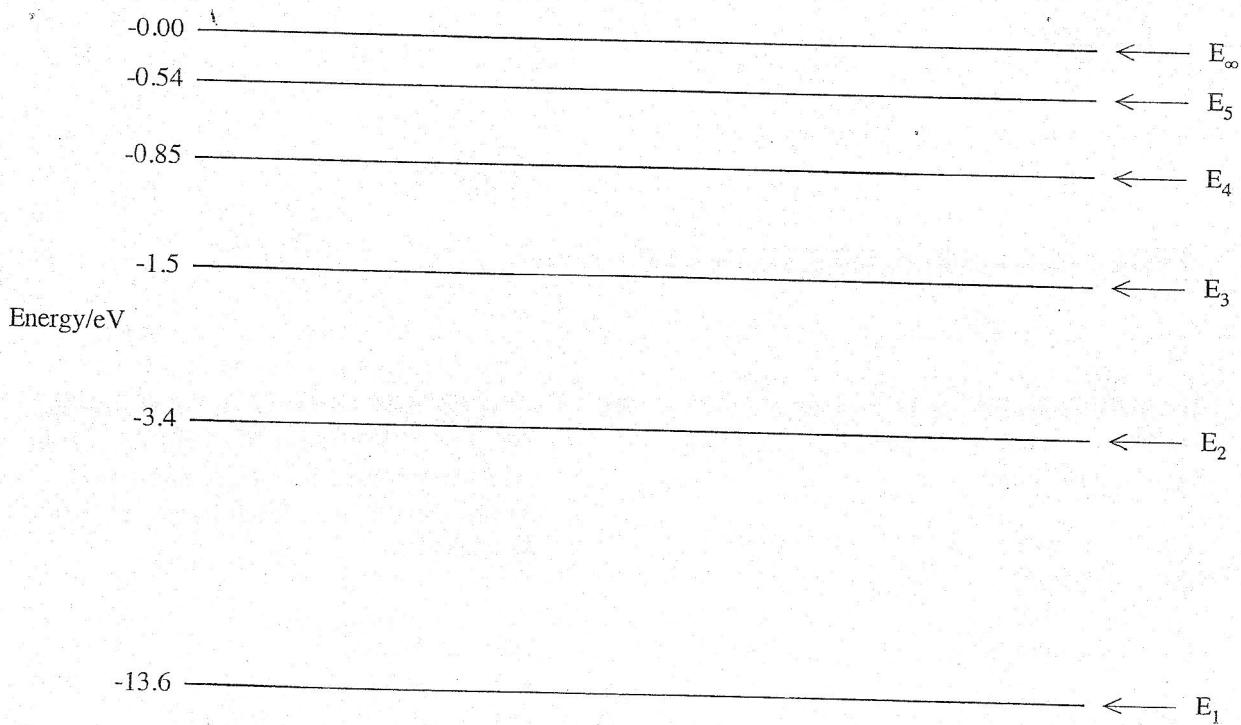
(A)  $6.08 \times 10^{-19}$  m  
 (B)  $1.09 \times 10^{-15}$  m  
 (C)  $3.27 \times 10^{-7}$  m  
 (D)  $9.17 \times 10^{14}$  m

Item 34 refers to the following diagram.



34. The graph above shows what happens when light of frequency  $7.5 \times 10^{14}$  Hz is incident on a metallic surface. The work function for the metal is
- (A)  $1.6 \times 10^{-19}$  J  
(B)  $3.4 \times 10^{-19}$  J  
(C)  $5.0 \times 10^{-19}$  J  
(D)  $6.6 \times 10^{-19}$  J

Item 35 refers to the following diagram which shows some of the electron energy levels in a hydrogen atom.



35. What is the energy required to ionize a hydrogen atom?

- (A) 0.85 eV  
(B) 10.2 eV  
(C) 13.6 eV  
(D) 19.9 eV

36. In the photoelectric effect, the work function is

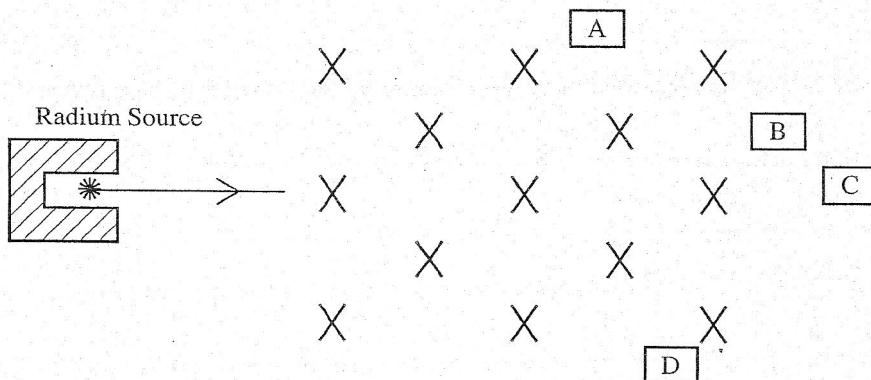
- (A) maximum kinetic energy of the electrons
- (B) the energy with which each electron is bound to the surface
- (C) the work done by the electron in reaching the collector
- (D) the energy the photon releases upon impact with the metal surface

37.

- If each of the following particles are moving at 0.2 c, where c is the speed of electromagnetic radiation, which particle has the longest de Broglie wavelength associated with it?

- (A) Electron
- (B) Hydrogen nucleus
- (C) Neutron
- (D) Alpha particle

38. A radium source is placed in a magnetic field as shown below. The field acts into the page.



At what position would a  $\beta$ -particle be detected?

39. The mass defect for the nucleus of helium is 0.0303 u. What is the binding energy per nucleon for helium?

- (A) 1 MeV
- (B) 4 MeV
- (C) 7 MeV
- (D) 28 MeV

40. What does  $\lambda$  represent in the equation,  $N = N_0 e^{(-\lambda t)}$ ?

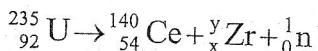
- (A) Wavelength
- (B) Decay constant
- (C) Frequency
- (D) Half-life

41.

- A freshly made sample of radioactive material gives a count rate of 8000 counts per minute. After twenty days, it gives a count-rate of 500 counts per minute. What is the half-life of the material?

- (A) 4 days
- (B) 5 days
- (C) 20 days
- (D) 80 days

42. The fission of Uranium - 235 can be represented by the nuclear equation



Which combination gives the correct value of  $y : x$ ?

- (A) 38 : 94
- (B) 86 : 140
- (C) 94 : 38
- (D) 38 : 235

43. When a radioactive nucleus decays an amount of energy, E, is released. At the same time, a small amount of mass, m, is lost. Which of the following gives the amount of energy?

- (A)  $E = \frac{1}{2}mc$
- (B)  $E = mc$
- (C)  $E = mc^2$
- (D)  $E = \frac{1}{2}mc^2$

44. A palladium nuclide is represented by  ${}_{91}^{232}\text{Pa}$ . Which of the following is correct for an atom of palladium?

	Number of protons	Number of neutrons	Number of electrons	Number of nucleons
(A)	91	232	141	323
(B)	91	91	323	141
(C)	141	91	141	232
(D)	91	141	91	232

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

- (A)  ${}_{82}^{203}\text{Pb}$
- (B)  ${}_{82}^{207}\text{Pb}$
- (C)  ${}_{84}^{211}\text{Po}$
- (D)  ${}_{84}^{207}\text{Po}$

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