FINAL JEE–MAIN EXAMINATION – APRIL, 2023

(Held OnThursday13thApril, 2023) **TIME :3 : 00 PM to 6 : 00 PM**

SECTION-A

31. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A : The binding energy per nucleon is practically independent of the atomic number for nuclei of mass number in the range 30 to 170.

Reason R : Nuclear force is short ranged.

In the light of the above statements, choose the ***correct*** answer from the options given below

Option :

(1) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

(2) **A** is true but **R** is false

(3) **A** is false but **R** is true

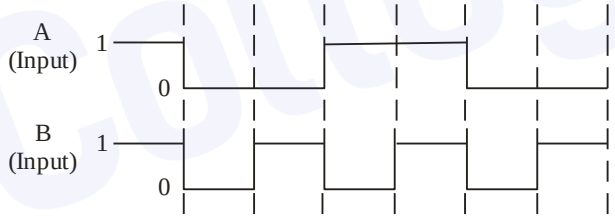
(4) Both **A** and **R** are true and **R** is the correct explanation of **A**

Official Ans. by NTA (4)

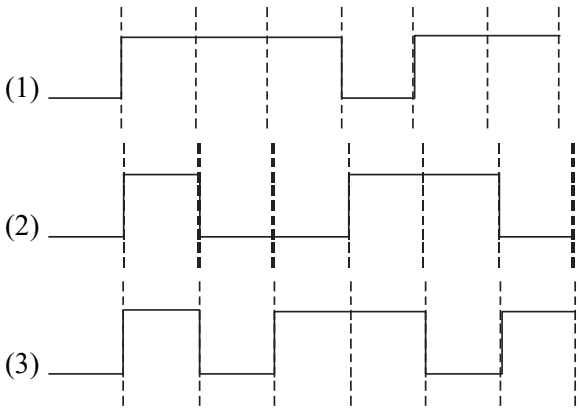
Ans. (4)

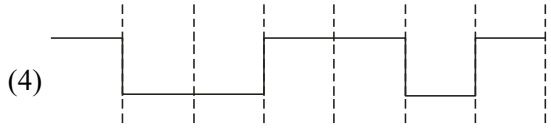
Sol. Binding energy per nucleon is almost same for nuclei of mass number ranging 30 to 170.

32. The output from a NAND gate having inputs A and B given below will be.



Option :





Official Ans. by NTA (1)

Ans. (1)

Sol. Truth table for NAND gate is

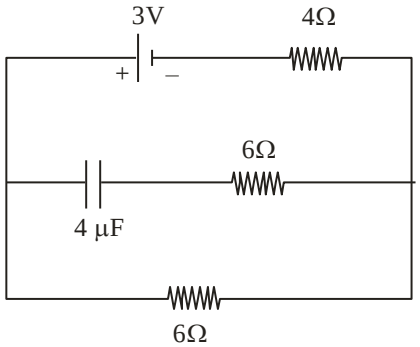
A	B	$Y = \overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

On the basis of given input A and B the truth table is

A	B	Y
1	1	0
0	0	1
0	1	1
1	0	1
1	1	0
0	0	1
0	1	1

So the correct answer is Option 1.

33. In the network shown below, the charge accumulated in the capacitor in steady state will be :



Option :

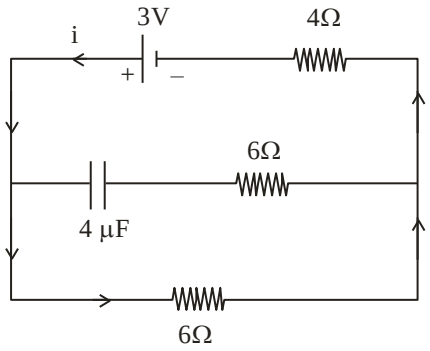
(1) 7.2 μC (2) 4.8 μC

(3) 10.3 μC (4) 12 μC

Official Ans. by NTA (1)

Ans. (1)

Sol.



No current will flow in capacitor in steady state, current flowing in the circuit in steady state

$$I = \frac{3}{6+4} = \frac{3}{10}$$

Potential difference on 6Ω resistance

$$V = 6 \times \frac{3}{10} = 1.8 \text{ volt}$$

Capacitor will have same potential so charge,

$q = CV = (4\ \mu F) \cdot (1.8 \text{ volt}) = 7.2\ \mu C.$

34. Given below are two statements :

Statement I: For a planet, if the ratio of mass of the planet to its radius increases, the escape velocity from the planet also increases.

Statement II: Escape velocity is independent of the radius of the planet.

In the light of above statements, choose the ***most appropriate*** answer from the options given below

Option :

(1) Both Statement I and Statement II are incorrect

(2) Statement I is correct but statement II is incorrect

(3) Statement I is incorrect but statement II is correct

(4) Both Statement I and Statement II are correct

Official Ans. by NTA (2)

Ans. (2)

Sol. $V_e = \sqrt{\frac{2GM}{R}} \Rightarrow V_e \propto \sqrt{\frac{M}{R}}$

As $\frac{M}{R}$ increases $\Rightarrow V_e$ increases

Statement (1) is correct

Also $V_e \propto \frac{1}{\sqrt{R}}$

As V_e depends upon R

$\Rightarrow$ Statement (2) is incorrect

Option (2) is correct

35. A particle executes SHM of amplitude A. The distance from the mean position when its's kinetic energy becomes equal to its potential energy is :

Option :

(1) $\sqrt{2A}$ (2) 2A

(3) $\frac{1}{\sqrt{2}}A$ (4) $\frac{1}{2}A$

Official Ans. by NTA (3)

Ans. (3)

Sol. KE = PE

$$\frac{1}{2}M\omega^2(A^2 - x^2) = \frac{1}{2}M\omega^2x^2$$

$$A^2 - x^2 = x^2 \Rightarrow A^2 = 2 \times 2$$

$$\Rightarrow x = \pm \frac{A}{\sqrt{2}}$$

36. A passenger sitting in a train A moving at 90 km/h observes another train B moving in the opposite direction for 8 s. If the velocity of the train B is 54 km/h, then length of train B is :

Option :

(1) 80 m (2) 200 m

(3) 120 m (4) 320 m

Official Ans. by NTA (4)

Ans. (4)

Sol. Velocity of train A

$$V_A = 90\frac{km}{hr} = 90 \times \frac{5}{18} = 25 \text{ m/s}$$

Velocity of train B

$$V_B = 54\frac{km}{hr} = 54 \times \frac{5}{18} = 15 \text{ m/s}$$

Velocity of train B w.r.t. train A $= \vec{V}_B - \vec{V}_A$

$= 15 - (-25)$ m/s

$= 40$ m/s

$$\text{Time of crossing} = \frac{\text{length of train}}{\text{relative velocity}}$$

$$(8) = \frac{\ell}{40}$$

$\ell = 8 \times 40 = 320$ meter.

37. The initial pressure and volume of an ideal gas are P_0 and V_0. The final pressure of the gas when the gas is suddenly compressed to volume $\frac{V_0}{4}$ will be :

(Given γ = ratio of specific heats at constant pressure and at constant volume)

Option :

(1) $P_0(4)^{\frac{1}{\gamma}}$ (2) $P_0(4)^{\gamma}$

(3) P_0 (4) $4P_0$

Official Ans. by NTA (2)

Ans. (2)

Sol. As gas is suddenly compressed, the processes is adiabatic.

Equation of gas for adiabatic process is PV^{γ} = constant.

$\Rightarrow P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$\Rightarrow P_0V_0^{\gamma} = P_2\left(\frac{V_0}{4}\right)^{\gamma}$

$\Rightarrow P_2 = P_0(4)^{\gamma}$

Option (2) is correct

38. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A : A spherical body of radius (5 ± 0.1) mm having a particular density is falling through a liquid of constant density. The percentage error in the calculation of its terminal velocity is 4%.

Reason R : The terminal velocity of the spherical body falling through the liquid is inversely proportional to its radius.

In the light of the above statements, choose the ***correct*** answer from the options given below

Option :

(1) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

(2) Both **A** and **R** are true and **R** is the correct explanation of **A**

(3) **A** is false but **R** is true

(4) **A** is true but **R** is false

Official Ans. by NTA (4)

Ans. (4)

Sol. Terminal velocity of a spherical body in liquid

$\Rightarrow V_t \propto r^2$

$\Rightarrow \frac{\Delta V_t}{V_t} = 2 \cdot \frac{\Delta r}{r}$

$\Rightarrow \frac{\Delta V_t}{V_t} \times 100\,\% = 2\frac{(0.1)}{5} \times 100 = 4\,\%$

Also $V_t \propto r^2$

Reason R is false

Option (4) is correct

39. In an electromagnetic wave, at an instant and at a particular position, the electric field is along the negative z-axis and magnetic field is along the positive x-axis. Then the direction of propagation of electromagnetic wave is :

Option :

(1) at 45° angle from positive y-axis

(2) negative y-axis

(3) positive z-axis

(4) positive y-axis

Official Ans. by NTA (2)

Ans. (2)

Sol. Direction of propagation of EM wave will be in the direction of $\vec{E} \times \vec{B}$.

40. The distance travelled by an object in time t is given by $s = (2{\cdot}5)t^2$. The instantaneous speed of the object at t = 5 s will be :

Option :

(1) 12.5 ms^{-1} (2) 62.5 ms^{-1}

(3) 5 ms^{-1} (4) 25 ms^{-1}

Official Ans. by NTA (4)

Ans. (4)

Sol. Distance (s) = $(2.5)t^2$

Speed (v) = $\frac{ds}{dt} = \frac{d}{dt}\{(2.5)t^2\}$

$v = 5t$

At t = 5, $v = 5 \times 5 = 25$ m/s.

Option (4) is correct

41. An electron is moving along the positive x-axis. If the uniform magnetic field is applied parallel to the negative z-axis. then

A. The electron will experience magnetic force along positive y-axis

B. The electron will experience magnetic force along negative y-axis

C. The electron will not experience any force in magnetic field

D. The electron will continue to move along the positive x-axis

E. The electron will move along circular path in magnetic field

Choose the correct answer from the options given below :

Option :

(1) B and E only (2) A and E only

(3) C and D only (4) B and D only

Official Ans. by NTA (1)

Ans. (1)

Sol. $\vec{F} = -e(\vec{v} \times \vec{B})$

Force will be along –ve y-axis.

As magnetic force is $\perp$ to velocity, path of electron must be a circle.

42. Two planets A and B of radii R and 1.5 R have densities ρ and $\rho/2$ respectively. The ratio of acceleration due to gravity at the surface of B to A is :

Option :

(1) 2 : 3 (2) 2 : 1

(3) 3 : 4 (4) 4 : 3

Official Ans. by NTA (3)

Ans. (3)

Sol. $g = \frac{GM}{R^2} = \frac{4}{3}\pi G\rho R$

$\therefore \frac{g_2}{g_1} = \frac{\rho_2}{\rho_1} \times \frac{R_2}{R_1} = \frac{1}{2} \times 1.5 = \frac{3}{4}$

43. Given below are two statements:

Statement I : An AC circuit undergoes electrical resonance if it contains either a capacitor or an inductor.

Statement II : An AC circuit containing a pure capacitor or a pure inductor consumes high power due to its non-zero power factor.

In the light of above statements, choose the ***correct*** answer from the options given below :

Option :

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Both Statement I and Statement II are true

(4) Statement I is false but Statement II is true

Official Ans. by NTA (1)

Ans. (1)

Sol. For resonance, $\phi = 0$, hence both inductor & capacitor must be present. Also power factor is zero for pure inductor or pure capacitor hence both the component consume zero average power.

44. A vehicle of mass 200 kg is moving along a levelled curved road of radius 70 m with angular velocity of 0.2 rad/s. The centripetal force acting on the vehicle is :

Option :

(1) 560 N (2) 2800 N

(3) 14 N (4) 2240 N

Official Ans. by NTA (1)

Ans. (1)

Sol. $F_c = m\omega^2 r = 200 \times (0.2)^2 \times 70 = 560$ N

45. To radiate EM signal of wavelength λ with high efficiency, the antennas should have a minimum size equal to :

Option :

(1) $\frac{\lambda}{2}$ (2) $\frac{\lambda}{4}$

(3) 2λ (4) λ

Official Ans. by NTA (2)

Ans. (2)

Sol. Minimum length of antenna should be $\frac{\lambda}{4}$.

46. Given below are two statements:

Statement I : Out of microwaves, infrared rays and ultraviolet rays, ultraviolet rays are the most effective for the emission of electrons from a metallic surface.

Statement II : Above the threshold frequency, the maximum kinetic energy of photoelectrons is inversely proportional to the frequency of the incident light.

In the light of above statements, choose the ***correct*** answer from the options given below

Option :

(1) Statement I is true but Statement II is false

(2) Both Statement I and Statement II are true

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are false

Official Ans. by NTA (1)

Ans. (1)

Sol. UV rays have maximum frequency hence are most effective for emission of electrons from a metallic surface.

$$KE_{max.} = hf - hf_0$$

47. A 10 μC charge is divided into two parts and placed at 1 cm distance so that the repulsive force between them is maximum. The charges of the two parts are :

Option :

(1) 9 μC, 1 μC (2) 5 μC, 5 μC

(3) 7 μC, 3 μC (4) 8 μC, 2 μC

Official Ans. by NTA (2)

Ans. (2)

Sol. Divide q = 10 μC into two parts x & q – x.

$$F = \frac{Kx(q-x)}{r^2}$$

For F to be maximum

$$\frac{dF}{dx} = \frac{K}{r^2}(q-2x) = 0$$

$$x = \frac{q}{2}$$

48. In the equation $\left[X + \frac{a}{Y^2}\right][Y - b] = RT$, X is pressure, Y is volume, R is universal gas constant and T is temperature. The physical quantity equivalent to the ratio $\frac{a}{b}$ is :

Option :

(1) Energy

(2) Impulse

(3) Pressure gradient

(4) Coefficient of viscosity

Official Ans. by NTA (1)

Ans. (1)

Sol. X and $\frac{a}{Y^2}$ have same dimensions

Y and b have same dimensions

$\therefore [a] = [ML^5T^{-2}]$

$[b] = [L^3]$

$\frac{[a]}{[b]} = [ML^2T^{-2}]$ has dimensions of energy

49. In a Young's double slits experiment, the ratio of amplitude of light coming from slits is 2:1. The ratio of the maximum to minimum intensity in the interference pattern is :

Option :

(1) 9 : 4 (2) 9 : 1

(3) 2 : 1 (4) 25 : 9

Official Ans. by NTA (2)

Ans. (2)

Sol. Given that $\frac{A_1}{A_2} = \frac{2}{1}$

$$\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2 = \frac{9}{1} = 9:1$$

50. The mean free path of molecules of a certain gas at STP is 1500d, where d is the diameter of the gas molecules. While maintaining the standard pressure, the mean free path of the molecules at 373K is approximately :

Option :

(1) 1098d (2) 2049d

(3) 750d (4) 1500d

Official Ans. by NTA (2)

Ans. (2)

Sol. Mean free path

$$\lambda = \frac{RT}{\sqrt{2}\pi d^2 N_A P}$$

$\lambda \propto T$

$$\frac{1500d}{\lambda} = \frac{273}{373}$$

$\lambda = 2049d$

SECTION-B

51. A bi convex lens of focal length 10 cm is cut in two identical parts along a plane perpendicular to the principal axis. The power of each lens after cut is _____ D.

Official Ans. by NTA (5)

Ans. (5)

Sol.

Let power of each part is P_1, then

$$P_1 + P_1 = P = \frac{1}{f}$$

$$2P_1 = \frac{1}{0.1} = 10$$

$$P_1 = 5D$$

52. An atom absorbs a photon of wavelength 500 nm and emits another photon of wavelength 600 nm. The net energy absorbed by the atom in this process is $n \times 10^{-4}$eV. The value of n is _____.

[Assume the atom to be stationary during the absorption and emission process]

(Take $h = 6.6 \times 10^{-34}$ Js and $c = 3 \times 10^8$ m/s).

Official Ans. by NTA (4125)

Ans. (4125)

Sol. $E = E_1 - E_2 = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2} = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

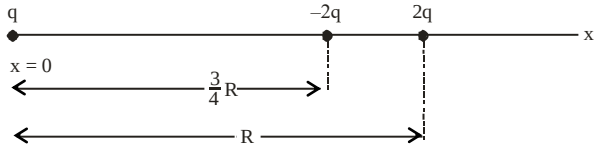
$$= 6.6 \times 10^{-34} \times 3 \times 10^8 \left(\frac{1}{500 \times 10^{-9}} - \frac{1}{600 \times 10^{-9}}\right)$$

$$= 6.6 \times 10^{-20} \text{ J}$$

$$= \frac{6.6 \times 10^{-20}}{1.6 \times 10^{-19}} \text{ eV} = 4.125 \times 10^{-1} \text{ eV}$$

$$= 4125 \times 10^{-4} \text{ eV}$$

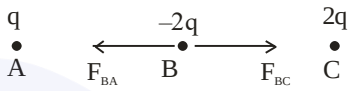
53. Three point charges q, –2q and 2q are placed on x-axis at a distance $x = 0$, $x = \frac{3}{4}R$ and $x = R$ respectively from origin as shown. If $q = 2 \times 10^{-6}$ C and R = 2 cm, the magnitude of net force experienced by the charge –2q is _____ N.



Official Ans. by NTA (5440)

Ans. (5440)

Sol.



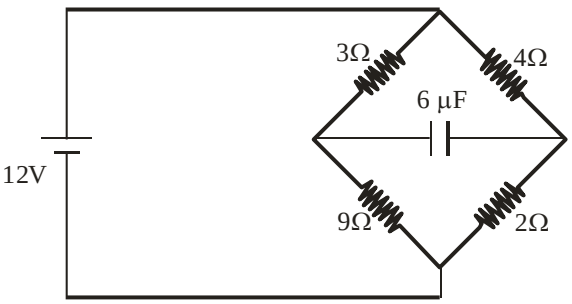
$$F_{BA} = \frac{Kq(2q)}{\left(\frac{3}{4}R\right)^2} = \frac{32Kq^2}{9R^2}$$

$$F_{BC} = \frac{K(2q)(2q)}{\left(\frac{R}{4}\right)^2} = \frac{\quad}{\quad}^2$$

$$F_B = F_{BC} - F_{BA} = \frac{544Kq^2}{9R^2}$$

$$= \frac{544 \times 9 \times 10^9 \times (2 \times 10^{-6})^2}{9 \times (2 \times 10^{-2})^2} = 5440 \text{ N}$$

54. In the circuit shown, the energy stored in the capacitor is n μJ. The value of n is _____.

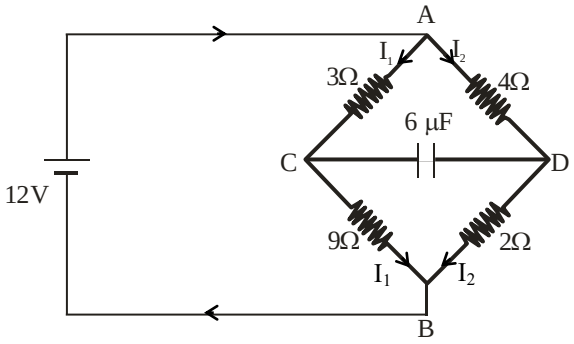


Official Ans. by NTA (75)

Ans. (75)

Sol. $I_1 = \dfrac{12}{3+9} = 1A$

$I_2 = \dfrac{12}{4+2} = 2A$



$V_A - V_C = 3I_1 = 3V$ ....(1)

$V_A - V_D = 2 \times 4 = 8V$ ....(2)

Subtracting eq. (1) from eq. (2)

$V_C - V_D = 5V \Rightarrow V = 5V$

$U = \dfrac{1}{2}CV^2 = \dfrac{1}{2} \times 6 \times 5^2 = 75\ \mu J$

55. An insulated copper wire of 100 turns is wrapped around a wooden cylindrical core of the cross-sectional area 24 cm^2. The two ends of the wire are connected to a resistor. The total resistance in the circuit is 12Ω. If an externally applied uniform magnetic field in the core along its axis changes from 1.5 T in one direction to 1.5 T in the opposite direction, the charge flowing through a point in the circuit during the change of magnetic field will be _____ mC.

Official Ans. by NTA (60)

Ans. (60)

Sol. $\Delta Q = -\dfrac{\Delta\phi}{R} = -\left(\dfrac{\phi_2 - \phi_1}{R}\right)$

$\phi_1 = NBA$

$\phi_2 = -NBA$

$\therefore \Delta Q = \dfrac{2NBA}{R} = \dfrac{2 \times 100 \times 1.5 \times 24 \times 10^{-4}}{12}$

$= 6 \times 10^{-2}\ C = 60\ mC$

56. In an experiment with sonometer when a mass of 180 g is attached to the string, it vibrates with fundamental frequency of 30 Hz. When a mass m is attached, the string vibrates with fundamental frequency of 50 Hz. The value of m is _____g.

Official Ans. by NTA (500)

Ans. (500)

Sol. $f = \dfrac{1}{2\ell}\sqrt{\dfrac{T}{\mu}}$ (T : Tension)

$\dfrac{f_2}{f_1} = \sqrt{\dfrac{T_2}{T_1}}$

$\left(\dfrac{50}{30}\right)^2 = \dfrac{mg}{180g} \Rightarrow m = \dfrac{25}{9} \times 180 = 500\ gram$

57. A light rope is wound around a hollow cylinder of mass 5 kg and radius 70 cm. The rope is pulled with a force of 52.5 N. The angular acceleration of the cylinder will be _____ rad s^{-2}.

Official Ans. by NTA (15)

Ans. (15)

Sol. $\tau = I\alpha$

$\Rightarrow FR = mR^2\alpha$

$\alpha = \dfrac{F}{mR} = \dfrac{52.5}{5 \times 0.7} = 15\ rad\ s^{-2}$

58. A car accelerates from rest to u m/s. The energy spent in this process is E J. The energy required to accelerate the car from u m/s to 2u m/s is nE J. The value of n is _____.

Official Ans. by NTA (3)

Ans. (3)

Sol. $E_1 = \dfrac{1}{2}mu^2 - 0 = \dfrac{1}{2}mu^2 = E$

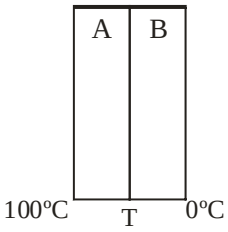
$E_2 = \dfrac{1}{2}m(2u)^2 - \dfrac{1}{2}mu^2 = \dfrac{3}{2}mu^2 = 3E$

59. Two plates A and B have thermal conductivities 84 $Wm^{-1}K^{-1}$ and 126 $Wm^{-1}K^{-1}$ respectively. They have same surface area and same thickness. They are placed in contact along their surfaces. If the temperatures of the outer surfaces of A and B are kept at 100 °C and 0 ºC respectively, then the temperature of the surface of contact in steady state is _____°C.

Official Ans. by NTA (40)

Ans. (40)

Sol.



Let the temperature of contact surface is T, then

$$H_A = H_B$$

$$\frac{K_A A(T_A - T)}{L} = \frac{K_B A(T - T_B)}{L}$$

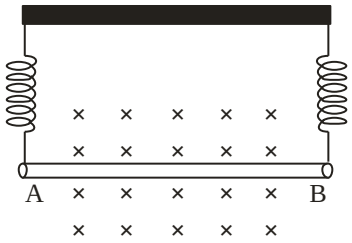
$84(100 - T) = 126\,(T - 0)$

$2(100 - T) = 3T$

$200 - 2T = 3T$

$T = 40ºC$

60. A straight wire AB of mass 40 g and length 50 cm is suspended by a pair of flexible leads in uniform magnetic field of magnitude 0.40 T as shown in the figure. The magnitude of the current required in the wire to remove the tension in the supporting leads is _____A. (Take g = 10 ms^{-2}).



Official Ans. by NTA (2)

Ans. (2)

Sol. For equilibrium

$Mg = I\ell B$

$$I = \frac{mg}{\ell B} = \frac{40 \times 10^{-3} \times 10}{50 \times 10^{-2} \times 0.4} = 2A$$