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PAPER-1 (B.E./B. TECH.)

JEE (Main) 2019

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 11 January, 2019 (SHIFT-1) | TIME : (9.30 a.m. to 12.30 p.m)

Duration: 3 Hours | Max. Marks: 360

SUBJECT : PHYSICS

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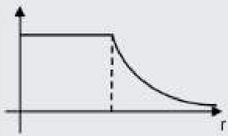
PART : PHYSICS

Straight Objective Type (सीधे वस्तुनिष्ठ प्रकार)

This section contains **30 multiple choice questions.** Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

इस खण्ड में **30** बहु–विकल्पी प्रश्न हैं। प्रत्येक प्रश्न के 4 विकल्प (1), (2), (3) तथा (4) हैं, जिनमें से सिर्फ एक सही है।

1. Identify the following graph ;
दिये गये ग्राफ को पहचानें :



(1) Electric potential of spherical shell
(2) Electric potential of solid sphere
(3) Electric field of solid sphere
(4) Electric field of spherical shell
(1) गोलीय कोश का विद्युत विभव
(2) ठोस गोले का विद्युत विभव
(3) ठोस गोले का विद्युत क्षेत्र
(4) गोलीय कोश का विद्युत क्षेत्र

Ans. **(1)**
Sol. Theoritical सैद्धान्तिक

2. An electron accelerated through 500V, enters a transverse uniform magnetic field of magnitude 100mT. The radius of the circular path described by the electron is nearly ;
एक इलेक्ट्रॉन 500V से त्वरित होने के पश्चात्, 100mT परिमाण के अनुप्रस्थ चुम्बकीय क्षेत्र में प्रवेश करता है। इलेक्ट्रॉन द्वारा तय किये गये वृत्ताकार पथ की त्रिज्या लगभग होगी :

(1) 7.54×10^{-1} m (2) 7.54×10^{-2} m (3) 7.54×10^{-3} m (4) 7.54×10^{-4} m

Ans. **(4)**

Sol. $r = \frac{\sqrt{2meV}}{eB}$

$= \sqrt{\frac{2meV_{ac}}{e^2B^2}}$

$= \sqrt{\frac{2 \times 9 \times 10^{-31} \times 500}{1.6 \times 10^{-19} \times (100 \times 10^{-3})^2}}$

$= \sqrt{\frac{2 \times 9.1 \times 10^{-31} \times 500}{1.6 \times 10^{-19} \times 10^{-2}}}$

$= \sqrt{\frac{2 \times 9.1 \times 5 \times 10^{-31+23}}{1.6}}$

$= \sqrt{\frac{9.1}{1.6} \times 10^{-7}}$

$= \sqrt{\frac{91}{16} \times 10^{-7}}$

$= \sqrt{\frac{910}{16} \times 10^{-8}}$

$= \sqrt{56.875} \times 10^{-4}$

$= 7.54 \times 10^{-4}$ m

3. An object is moving in a circular path. The change in velocity when the object is moved by an angle of 60°, is:

एक वस्तु एक वृत्त में 10 m/s की चाल से घूमती है। जब वस्तु 60° कोण से घूमती है तब वेग में परिवर्तन होगा :

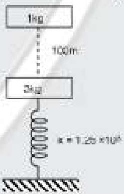
(1) 10 m/s (2) $10\sqrt{3}$ (3) 0 (4) $10\sqrt{2}$

Ans. (1)

Sol. $|\Delta \vec{V}| = 2v\sin\frac{\theta}{2} = 2v\sin 30° = 2 \times 10 \times \frac{1}{2} = 10$ m/s

4. A block of mass 1 kg is dropped on a spring mass system as shown in figure. The block travels 100 meter in air before striking the 3 kg mass. Calculate maximum compression in the spring, if both the blocks moves together after the collision ($k = 1.25 \times 10^6$)

1 kg द्रव्यमान के गुटके को दर्शायेनुसार एक स्प्रिंग द्रव्यमान निकाय पर छोड़ा जाता है। 3 kg द्रव्यमान के गुटके से टकराने से पहले गुटका हवा में 100 मीटर चलता है। स्प्रिंग में अधिकतम सम्पीडन होगा, यदि दोनों गुटके टकराने के पश्चात् एक साथ चलते हैं। ($k = 1.25 \times 10^6$):



(1) 2 cm (2) 4 cm (3) 8 cm (4) 16cm

Ans. (1)

Sol. Initial compression is negligible

Compression will be significant due to collision.

velocity after collision

$1 \times \sqrt{2 \times 10 \times 100} = 4 \times v$

$v = 5\sqrt{5}$ m/s

Assuming this as maximum velocity

$v = \omega A$

$5\sqrt{5} = \sqrt{\frac{1.25 \times 10^6}{4}}\ A$

$A = 5 \times 2 \times 2 \times 10^{-3}$ m $= 2$ cm

Sol. प्रारम्भिक सम्पीडन नगण्य है

टकराने के पश्चात् सम्पीडन माननीय है

टकराने के पश्चात् वेग

$1 \times \sqrt{2 \times 10 \times 100} = 4 \times v$

$v = 5\sqrt{5}$ m/s

माना यह अधिकतम वेग है

$v = \omega A$

$5\sqrt{5} = \sqrt{\frac{1.25 \times 10^6}{4}}\ A$

$A = 5 \times 2 \times 2 \times 10^{-3}$ m $= 2$ cm

5. The expression of a force (F) is given by ;

$$F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kT}\right)$$

where x is distance, k is Boltzmann constant, T is absolute temperature. The dimension of β is :

बल (F) का समीकरण

$$F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kT}\right)$$

से दिया जाता है। जहाँ x दूरी, k बोल्ट्जमेन नियतांक, T निरपेक्ष तापमान है। β की विमा है :

(1) $[M^2LT^{-2}]$ (2) $[M^0L^0T^{-4}]$ (3) $[M^2L^2T^{-2}]$ (4) $[M^2LT^{-4}]$

Ans. **(4)**

Sol. Exponential terms are dimensionless :

घातीय राशियाँ विमाहीन हैं :

$\left(-\frac{x^2}{\alpha kT}\right) = [M^0L^0T^0]$

$\therefore \quad \frac{[L^2]}{[\alpha][ML^2T^{-2}]} = [M^0L^0T^0]$ [kT is thermal energy] [kT ऊष्मीय ऊर्जा है]

$\therefore \quad [\alpha] = [M^{-1}T^2]$ $\quad \therefore [kT] = [ML^2T^{-2}]$

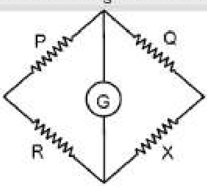
Now $[F] = [\alpha\beta]$

$\therefore \quad [MLT^{-2}] = [M^{-1}T^2][\beta]$

$\therefore \quad [\beta] = [M^2LT^{-4}]$

6. In a wheatstone bridge setup, P and Q are approximately equal. Initially R = 400Ω. at balancing conditions. When P and Q are inter changed. the bridge is balanced for R = 405Ω. Then the value of X is.

एक व्हीटस्टोन ब्रिज निकाय में, P और Q लगभग समान हैं, प्रारम्भ में R = 400Ω है। जब P तथा Q को संतुलित अवस्था में परस्पर बदल दिया जाये तब संतुलित अवस्था के लिये R = 405Ω है। X का मान होगा :



(1) 401.5 (2) 402.5 (3) 403.5 (4) 404.5

Ans. **(2)**

Sol. Initially प्रारम्भ में

$$\frac{P}{Q} = \frac{R_1}{X} \quad \ldots(i)$$

After interchanging P and Q

P व Q को परस्पर बदलने पर

$$\frac{Q}{P} = \frac{R_2}{X} \quad \ldots(ii)$$

From (i) and (ii)

$$1 = \frac{R_1R_2}{X^2}$$

$$X = \sqrt{R_1R_2}$$

$$= \sqrt{400 \times 405}$$

$$= 402.5\ \Omega$$

7. 50 grams water at 40°C is mixed with ice at –20°C. If final temperature of the mixture becomes 0°C and 20 gm ice remains unmelted, then the mass of ice is:

(1) 40gm (2) 50 gm (3) 30 gm (4) 60 gm

Ans. **(1)**

Sol. Heat lost by water $\Delta Q = ms\Delta T = 50 \times 1 \times 40 = 2000$ cal

Let mass of ice = m

Heat gain by ice $\Delta Q = m \times \frac{1}{2} \times 20 + (m - 20) \times 80$

$= 10\ m + 80\ m - 1600 = 90\ m - 1600$

Heat gain = Heat lost

$90\ m - 1600 = 2000$

$m = 40$ gm

8. An electromagnetic wave of intensity 50 W/m² enters into a medium of refractive index n without any loss of intensity :

Then, the ratio of Electric field in second medium to first medium and the ratio of magnetic field in second medium to first medium are respectively :

(1) $\left(\frac{1}{\sqrt{n}}, \frac{1}{\sqrt{n}}\right)$ (2) $\left(\sqrt{n}, \sqrt{n}\right)$ (3) $\left(\sqrt{n}, \frac{1}{\sqrt{n}}\right)$ (4) $\left(\frac{1}{\sqrt{n}}, \sqrt{n}\right)$

Ans. **(4)**

Sol. In air $\frac{E_0}{B_0} = C$

In the medium of refractive index = n

$$\frac{E}{B} = \frac{C}{n}$$

It is possible if

$E = \frac{E_0}{\sqrt{n}}$ and $B = B_0\sqrt{n}$

$$\therefore \frac{E}{E_0} = \frac{1}{\sqrt{n}}, \frac{B}{B_0} = \sqrt{n}$$

9. A satellite is revolving at a height h from the surface of earth. Then the change in velocity for the satellite to escape the gravitational field of earth, is:

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

Ans. (2)

Sol. Orbital velocity, $v_0 = \sqrt{\frac{GM}{(R+h)}}$

to escape, $v_s = \sqrt{\frac{2GM}{(R+h)}}$

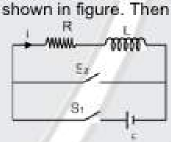
change in velocity = $\sqrt{\frac{2GM}{(R+h)}} - \sqrt{\frac{GM}{(R+h)}}$

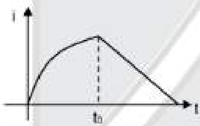
if h << R

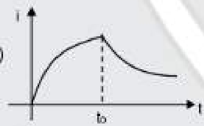
$\Delta v = \sqrt{\frac{2GM}{R}} - \sqrt{\frac{GM}{R}}$

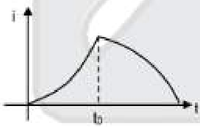
$\Delta v = \sqrt{2gR} - \sqrt{gR}$

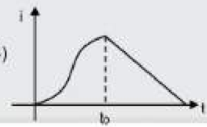
10. In the given L–R circuit, the switch S_1 is initially closed and S_2 is open. At any time $t = t_0$, the switch S_1 is opened and S_2 is closed. The current (i) vs time (t) graph for the entire time during which it passes through the inductor is shown in figure. Then the best suitable graph is :



(1)


(2)


(3)


(4)


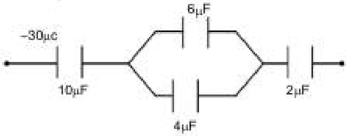
Ans. (2)

Sol. Growth and decay of current is of exponential nature

$i = i_0(1 - e^{-t/\tau}) \rightarrow$ during growth

$i = i_{max}\, e^{-t/\tau} \rightarrow$ during decay

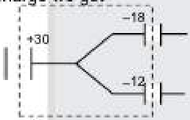
11. In the given circuit, charge on the left plate of 10 μF capacitor is –30μc. Find the charge on the right plate of capacitor of capacitance 6μF.



(1) –18 μc (2) 18 μc (3) 12 μc (4) –12 μc

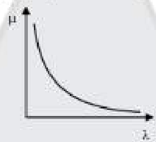
Ans. (2)

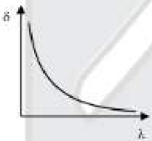
Sol. Applying the concept of charge conservation on isolated plates of 10μF, 6μF & 4μF and distribuiting the charge we get

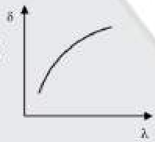


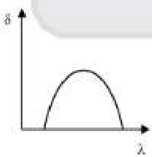
$= \frac{6}{(6+4)} \times 30 \text{ mc} = +18\ \mu c$

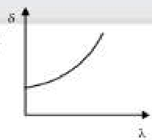
12. The refrective index (μ) vs wavelength (λ) graph for a prism is as shown in the figure. The graph of angle of deviation (δ) vs wavelength (λ) graph is best represented by :



(1)


(2)


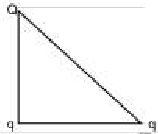
(3)


(4)


Ans. (1)

Sol. $\delta = A(\mu - 1)$ for thin prism, then more is the refractive index, more will be the deviation.

13. Three point chages q, q and Q are placed at the vertices of an right angled isosceles triangle as shown in the figure. If the system has total electro-static potential energy of the system is zero, then the value of Q is



(1) $-\dfrac{q}{(\sqrt{2}+1)}$ (2) $-\dfrac{q\sqrt{2}}{\sqrt{2}+1}$ (3) $-\dfrac{q\sqrt{2}}{\sqrt{2}-1}$ (4) $-\dfrac{q\sqrt{3}}{\sqrt{2}-1}$

Ans. **(2)**

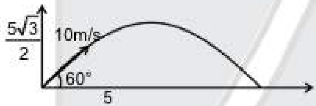
Sol. $\dfrac{1}{4\pi\varepsilon_0}\left(\dfrac{q^2}{a}+\dfrac{Q^2}{a}+\dfrac{Qq}{\sqrt{2}a}\right)=0$, Solving : $Q=-\dfrac{\sqrt{2}a}{(\sqrt{2}+1)}$

14. A particle is projected with speed of 10 m/s at an angle of 60^0 with the horizontal. Then the radius of curvature of the path of the particle at the point where it reaches after 1s of projection, is :

(1) 10.3 (2) 2.67 (3) 2.24 (4) 12.4

Ans. **(2)**

Sol.



at t = 1s $v_y = 5\sqrt{3} - 10 \times 1$ $V=\sqrt{25+(5\sqrt{3}-10)^2}$

$v_x = 5$ $=\sqrt{25+75+100-100\sqrt{3}} = \sqrt{200-100\sqrt{3}} = 5.11$

$r_c = \dfrac{v^2}{g\cos\phi} = \dfrac{v^2}{g\dfrac{u_x}{v}} = \dfrac{v^3}{gu_x} = \dfrac{(5.11)^3}{10\times 5} = 2.67\text{m}$

15. An object is kept at a distance of 20m from a convex lens of focal length 0.3 m. It is moving with 5m/s on principal axis away from lens. Speed of image will be :

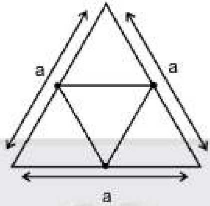
(1) 1.22×10^{-3} m/s towards lens (2) 2.1×10^{-3} m/s away from lens

(3) 0.91×10^{-3} m/s away from lens (4) 2.1×10^{-3} m/s towards lens

Ans. **(1)**

Sol. $\dfrac{dv}{dt}=\left(\dfrac{f}{f+u}\right)^2\dfrac{du}{dt}$ $\Rightarrow$ $\dfrac{dv}{dt}=\left(\dfrac{0.3}{0.3-20}\right)^2\times 5 = 1.25 \times 10^{-3}$ m/s towards lens

16. From a triangular lamina of side a and mass m, a small triangular lamina made by joining mid points of sides of triangular lamina is cut. If moment of inertia of complete lamina about centroid is I_0, then the moment of inertia of remaining lamina about centroid is :



(1) $\frac{I_0}{16}$ (2) $\frac{3I_0}{4}$ (3) $\frac{15I_0}{16}$ (4) $\frac{I_0}{8}$

Ans. (3)

Sol. From Dimension analysis $I_0 = kMa^2$

Now for small lamina

$$I' = k\frac{M}{4}\left(\frac{a}{2}\right)^2 = \frac{kMa^2}{16}$$

$$I' = \frac{I_0}{16}$$

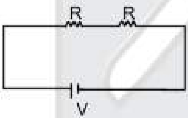
So moment of inertia of remaining part $I - I' = \frac{15I_0}{16}$

17. Power generated across two resistors, each of resistance R in series, is 60W. If same resistors are now connected in parallel with the same battery, power generated across them will be

(1) 240 watt (2) 120 watt (3) 60 watt (4) 30 watt

Ans. (1)

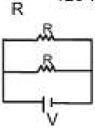
Sol.



$P_{generated} = 60W$

$$P = 60 = \frac{V^2}{2R}$$

$$\frac{V^2}{R} = 120 \text{ watt}$$



$$P_{generated} = \frac{2V^2}{R} = 2(120) = 240 \text{ watt}$$

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18. Hydrogen atom in ground state is being irradiated with light of wavelength 980 Å. If bohr radius is a_0 then the new radius of the orbit to which the electron will get excited from ground state is :
(hc = 12500 eV–Å)

(1) $25a_0$ (2) $9a_0$ (3) $4a_0$ (4) $16a_0$

Ans. **(4)**

Sol. Energy of radiation = $\frac{12500}{980}$ = 12.75eV

Energy of electron in n^{th} orbit = $-\frac{13.6}{n^2}$

$\Rightarrow \quad E_n - E_1 = -13.6\left[\frac{1}{n^2} - \frac{1}{1^2}\right]$

$\Rightarrow \quad 12.75 = 13.6\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$

$\Rightarrow \quad n \approx 4$

Electron will transit to n = 4

New radius will be $16a_0$.

19. The displacement of particle is executing simple harmonic motion is described by the equation x = A sin $\left(\frac{\pi t}{90}\right)$. The ratio of kinetic to the potential energy of the particle at t = 210s is

(1) 1 : 2 (2) 1 : 3 (3) 2 : 1 (4) 3 : 1

Ans. **(2)**

Sol. $x|_{t=210} = A\sin\left[\left(\frac{\pi}{90}\right)\times 210\right] = A\sin\left(2\pi + \frac{\pi}{3}\right) = \frac{\sqrt{3}A}{2}$

P.E. (V) = $\frac{1}{2}kx^2 = \frac{1}{2}k\left(\frac{3A^2}{4}\right)$

K.E. (T) = $\frac{1}{2}mv^2 = \frac{1}{2}m\omega^2\left(\sqrt{A^2 - \frac{3A^2}{4}}\right)^2 = \frac{1}{2}\frac{KA^2}{4}$

$\therefore$ Required ratio $\frac{T}{U} = \frac{1}{3}$

20. 3 moles of O_2 and 5 moles of Ar are mixed at temperature 'T'. Then the internal energy of the gas is

(1) 11RT (2) 6RT (3) 15RT (4) $\frac{11}{3}$RT

Ans. **(3)**

Sol. $f_{mix} = \frac{n_1f_1 + n_2f_2}{n_1 + n_2} = \frac{3\times 5 + 5\times 3}{8} = \frac{15}{4}$

$U = \frac{f}{2}nRT = \frac{15}{2\times 4}\times 8\,RT = 15RT$

21. Two solenoids of equal length but different number of turns per unit length are placed coaxially n_1 and n_2 are the number of turns per unit length of outer and inner solenoids respectively. Radius of inner and outer solenoid are R_1 and R_2 respectively. The ratio of mutual inductance to self inductance of inner inductor is

(1) $\frac{n_2}{n_1}$ (2) $\frac{n_1}{n_2}$ (3) $\frac{n_1}{n_2}\times\frac{R_1^2}{R_2^2}$ (4) $\frac{n_1}{n_2}\times\frac{R_1}{R_2}$

Ans. **(2)**

Sol. Mutual inductance = $\mu_0 n_1 n_2 R_2^2 \ell$

Self inductance of inner solenoid = $\mu_0 n_2^2 R_2^2 \ell$

Ratio = $\frac{n_1}{n_2}$

22. For a diatomic gas undergoing adiabatic process follows TV^x = constant. The value of x is –

(1) 2/5 (2) 3/5 (3) 7/5 (4) 4/5

Ans. **(1)**

Sol. For adiabatic process

$TV^{\gamma-1}$ = Constant

$\gamma = 1 + \frac{2}{5} = \frac{7}{5}$ (For diatomic gas)

So $x = \gamma - 1 = \frac{7}{5} - 1 = \frac{2}{5}$

23. Equation of a traveling wave set up on a string is $y = A \sin[(9m^{-1})x - (450s^{-1})t]$. If linear mass density of the string is 5gm/m. Then the tension in string is

(1) 10N (2) 25N (3) 12.5N (4) 50N

Ans. **(3)**

Sol. $k = 9 \quad \omega = 450$

$\therefore v = \frac{\omega}{k} = 50$ m/s

$v = \sqrt{\frac{T}{\mu}}$

$\therefore T = \mu v^2 = 50^2 \times 5 \times 10^{-3} = 12.5N$

24. In YDSE intensity at central maxima is I_0. Then ratio $\frac{I}{I_0}$ at path difference $\frac{\lambda}{8}$ on screen from central maxima is closed to

(1) 0.74 (2) 0.8 (3) 0.9 (4) 0.85

Ans. **(4)**

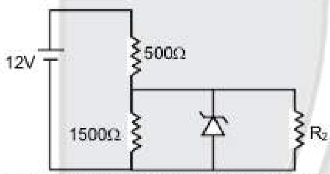
Sol. $\Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{8} = \frac{\pi}{4}$

$I = I_0 \cos^2 \frac{\pi}{8}$

$= I_0 \left(\frac{1+\cos\pi/4}{2}\right)$

$= I_0 \left(\frac{1+\frac{1}{\sqrt{2}}}{2}\right) = 0.85\ I_0$

25.

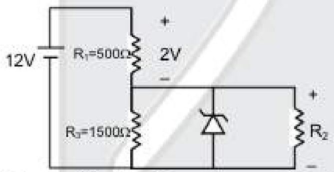


A zener diode of zener break–down voltage 10V is connected as shown in figure. Current through zener diode is

(1) 4mA (2) 0.6 mA (3) 6 mA (4) zero

Ans. (4)

Sol.



If we consider break down in zener diode, then potential across R_3 will be 10V and R_1 will be 2V.

So current in R_3 will be $i_3 = \frac{10}{1500} = \frac{2}{300}$ A

and current in R_1 will be $i_1 = \frac{2}{500}$ A

⇒ $i_1 < i_3$, which is not possible

⇒ Potential difference across zener diode does not reach to break down voltage. so no current will flow through reverse biased zener diode.

26. Water coming with velocity v drops onto a mesh. 50% pass by, 25% loses momentum and 25% bounces back. Find pressure an mesh -

(1) $\frac{1}{2}\rho v^2$ (2) $\frac{3}{2}\rho v^2$ (3) $3\rho v^2$ (4) $\frac{3}{4}\rho v^2$

Ans. (4)

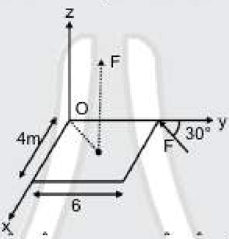
Sol. Mass per unit time = 3Av

Force due to momentum loss = $\frac{1}{4}\rho Av \times v^2$

Force due to bounce back = $\frac{1}{4}\rho Av \times 2v^2$

Pressure = $\dfrac{\frac{\rho Av^2}{4} \times \frac{\rho Av^2}{2}}{A} = \frac{3}{4}\rho v^2$

27. Two forces on a plane is applied as shown in figure. Calculate moment of these forces about point O.



(1) $(2\hat{i} - 3\hat{j} - 3\hat{k})$ (2) $(2\hat{i} + 3\hat{j} + 3\hat{k})$ (3) $(2\hat{i} - 3\hat{j} + 3\hat{k})$ (4) $(-2\hat{i} + 3\hat{j} + 3\hat{k})$

Ans. **(3)**

Sol. $T_0 = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2$

$= (3\hat{i} + 2\hat{j}) \times F(\hat{k}) + 6\hat{j} \times \left(\frac{F}{2}(-\hat{i}) + \frac{F\sqrt{3}}{2}(-\hat{j})\right)$

$= 3F(-\hat{j}) + 2F(\hat{i}) + 3F(\hat{k}) + 0$

$= (2\hat{i} - 3\hat{j} + 3\hat{k})F$