1. If $\vec{a} = \hat{i} + 2\hat{j} - \hat{k}$, $\vec{b} = 2\hat{i} - \hat{j} + 3\hat{k}$, and $\vec{c} = -\hat{i} + 3\hat{j} + 2\hat{k}$, find $\vec{a} \cdot (\vec{b} \times \vec{c})$.

(1) 15

(2) -30

(3) 20

(4) -20

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2. If the word "GIFT" is coded using A=1, B=2, ..., Z=26, and each letter's value is squared, what is the sum of the coded values?

(1) 166

(2) 216

(3) 234

(4) 252

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3. From the top of a 60 m high building, the angles of depression to two points on the ground on the same side of the building are 30° and 60°. What is the distance between the two points?

(1) $40\sqrt{3}$ m

(2) $20\sqrt{3}$ m

(3) 60 m

(4) 80 m

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4. Maximize $z = 3x + 4y$ subject to $x + y \leq 4$, $x \geq 0$, $y \geq 0$. What is the maximum value of z?

(1) 12

(2) 16

(3) 14

(4) 10

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5. Find the sum of the series $1 + 3 + 5 + \ldots + 99$.

(1) 2500

(2) 2400

(3) 2600

(4) 2300

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6. If $\vec{p} = 3\hat{i} - \hat{j} + 2\hat{k}$, $\vec{q} = \hat{i} + 4\hat{j} - \hat{k}$, and $\vec{r} = 2\hat{i} - 3\hat{j} + 5\hat{k}$, find $\vec{p} \cdot (\vec{q} \times \vec{r})$.

(1) 36

(2) -36

(3) 65

(4) -65

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7. If the word "BITS" is coded using $A = 1, B = 2, \ldots, Z = 26$, and the code is the sum of the squares of each letter's value, what is the code for the word?

(1) 846

(2) 854

(3) 864

(4) 874

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8. Maximize $z = 5x + 2y$ subject to $2x + y \leq 8$, $x \geq 0$, $y \geq 0$. What is the maximum value of z?

(1) 40

(2) 30

(3) 25

(4) 20

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9. From the top of a 50 m tall building, the angles of depression to two points on the ground are 45° and 30°. Find the distance between the two points.

(1) $20(\sqrt{3} - 1)$ m

(2) $25(\sqrt{3} - 1)$ m

(3) $30(\sqrt{3} - 1)$ m

(4) $50(\sqrt{3} - 1)$ m

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10. A projectile is launched with an initial velocity of 20 m/s at an angle of 30° with the horizontal. What is the maximum height reached by the projectile? (Take $g = 10\,\text{m/s}^2$)

(1) $5\,\text{m}$

(2) $10\,\text{m}$

(3) $15\,\text{m}$

(4) $20\,\text{m}$

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11. How much heat is required to raise the temperature of $2\,\text{kg}$ of water from $25^\circ C$ to $75^\circ C$? (Specific heat capacity of water $c = 4200\,\text{J/kg}^\circ C$)

(1) $4.2 \times 10^5\,\text{J}$

(2) $5.0 \times 10^5\,\text{J}$

(3) $3.5 \times 10^5\,\text{J}$

(4) $4.8 \times 10^5\,\text{J}$

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12. Which of the following is the correct electronic configuration of Cr (Chromium, atomic number 24)?

(1) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^4\,4s^2$

(2) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^1$

(3) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^6\,4s^0$

(4) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3\,4s^3$

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13. For the reaction $A + B \rightarrow C$, the rate law is found to be rate $= k[A]^2[B]$. If the concentration of A is doubled and B is halved, by what factor does the rate change?

(1) 2

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

(3) 4

(4) 1

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14. In the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \leftrightarrow 2\text{NH}_3(\text{g})$, if the equilibrium constant $K_c = 4 \times 10^{-3}$ at a certain temperature, which of the following is true about the reaction at equilibrium?

(1) Reactants are favored over products

(2) Products are favored over reactants

(3) Reactants and products are equally favored

(4) Reaction does not reach equilibrium

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15. In the electrolysis of molten $NaCl$, what is produced at the cathode?

(1) Chlorine gas

(2) Sodium metal

(3) Hydrogen gas

(4) Oxygen gas
