

DAILY TEST SERIES FOR IIT-JEE 2009 FROM VIDYA DRISHTI

12.03.2009

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Total time for six questions: 20 min

Single/Multiple choice question: There can be single or multiple choices.

Physics

1. A cubical block of mass m and edge a slides down a rough inclined plane of inclination θ with a uniform speed. The torque of the normal force acting on the block about its centre is
 - (a) Zero
 - (b) $\frac{1}{2} mg a \sin\theta$
 - (c) $\frac{1}{2} mg a \cos\theta$
 - (d) None of the above
2. A block is kept on the floor of an elevator at rest. The elevator starts descending with an acceleration of 12m/s^2 . The displacement of the block during the first 0.2 s after the start assuming $g = 10 \text{ m/s}^2$ is
 - (a) 4 cm
 - (b) 20 cm
 - (c) 24 cm
 - (d) None of the above

Mathematics

3. The value of $\lim_{x \rightarrow \infty} \frac{\left(\int_0^x e^{x^2} dx \right)^2}{\int_0^x e^{2x^2} dx} =$
 - (a) 0
 - (b) 1
 - (c) e
 - (d) undefined

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$$4. \text{ If } f(x) = \begin{cases} \sin x, & x \neq n\pi \\ 2, & x = n\pi \end{cases}$$

$$g(x) = \begin{cases} x^2 + 1, & x \neq 0, x \neq 2 \\ 4, & x = 0 \\ 5, & x = 2 \end{cases}$$

Then $\lim_{x \rightarrow 0} g f(x) =$

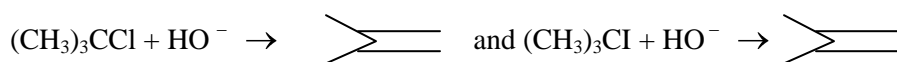
- (a) 0
- (b) 1
- (c) 2
- (d) 3

Chemistry

5. If trimethylphosphene is added to solution of Ni(II) chloride in acetone, a blue compound of molar mass 280 is isolated. This compound in analysis gave the following composition:
Ni = 21.5%, Cl = 26% and $(\text{CH}_3)_3\text{P} = 52.5\%$

This blue compound does not have any isomeric forms. Choose the correct option/s

- (a) Molecular formula is $[\text{NiCl}_2 ((\text{CH}_3)_3\text{P})_2]$
 - (b) Complex is tetrahedral
 - (c) sp^3 hybridization
 - (d) Magnetic moment = 3.82 BM
6. Discuss the relative reactivity of reactants in the following pairs:



- (a) $(\text{CH}_3)_3\text{CCl}$ is more reactive
- (b) $(\text{CH}_3)_3\text{CI}$ is more reactive
- (c) Both are equally reactive
- (d) None of the above

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SOLUTION:

1. (b)

This question involves an important concept. Idea is that normal force needs not to pass through centre. When the block is in motion, normal force shifts a bit forward of the motion. Using this fact we can draw FBD as shown in the figure.

As the block is not rotating (rotational equilibrium), therefore
Net torque about centre = 0

$$\Leftrightarrow \tau_N - f(a/2) = 0 \quad (\text{here } \tau_N \text{ is the torque of the normal force about the centre})$$

$$\Leftrightarrow \tau_N = fa/2 \quad \dots(1)$$

As the block moving with a uniform speed, acceleration = zero.

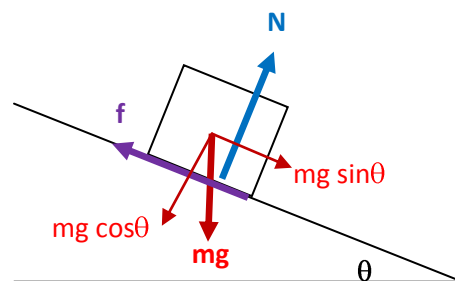
Therefore, using Newton's 2nd law along horizontal, we have

$$mg \sin\theta - f = 0$$

$$\Leftrightarrow f = mg \sin\theta$$

Putting this value of $f = mg \sin\theta$ in (1), we get

$$\tau_N = \frac{1}{2} mg a \sin\theta$$



2. (b)

This question is bit tricky.

Idea is that acceleration of the lift is 12m/s^2 which is greater than acceleration due to gravity.

Hence, when lift starts descending with this acceleration, block loses contact with the floor and starts falling under the action of gravity.

Thus, acceleration of the block = acceleration due to gravity = 10 m/s^2 (downward)

Hence using $s = ut + \frac{1}{2} at^2$ along downward direction, we have

$$s = 0 \times 0.2 + \frac{1}{2} \times 10 \times 0.2^2$$

$$\Leftrightarrow s = 0.2\text{ m} = 20\text{ cm}.$$

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3. (a)

$$I = \lim_{x \rightarrow \infty} \frac{\left(\int_0^x e^{x^2} dx \right)^2}{\int_0^x e^{2x^2} dx} \quad \left(\frac{\infty}{\infty} \text{ form} \right)$$

$$= \lim_{x \rightarrow \infty} \frac{2 \int_0^x e^{x^2} dx \cdot e^{x^2}}{e^{2x^2}} \quad (\text{by L' Hospital Rule})$$

$$= \lim_{x \rightarrow \infty} \frac{2 \int_0^x e^{x^2} dx}{e^{-x^2}} \quad \left(\frac{\infty}{\infty} \text{ form} \right)$$

$$= \lim_{x \rightarrow \infty} \frac{2e^{x^2}}{e^{-x^2} \cdot 2x} \quad (\text{by L' Hospital Rule})$$

$$= \lim_{x \rightarrow \infty} \frac{1}{x}$$

$$= 0$$

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4. (b)

$$g(x) = \begin{cases} x^2 + 1, & x \neq 0, x \neq 2 \\ 4, & x = 0 \\ 5, & x = 2 \end{cases}$$

Therefore,

$$g\{f(x)\} = \begin{cases} [f(x)]^2 + 1, & f(x) \neq 0, f(x) \neq 2 \\ 4, & f(x) = 0 \\ 5, & f(x) = 2 \end{cases}$$

$$= \begin{cases} \sin^2 x + 1, & \sin x \neq 0, \sin x \neq 2 \text{ \& } x \neq n\pi \\ 4, & \sin x = 0 \text{ \& } x \neq n\pi \\ 5, & \sin x = 2 \text{ \& } x \neq n\pi \\ (2)^2 + 1, & 2 \neq 0, 2 \neq 2 \text{ \& } x = n\pi \\ 4, & 2 = 0 \text{ \& } x = n\pi \\ 5, & 2 = 2 \text{ \& } x = n\pi \end{cases}$$

$$= \begin{cases} \sin^2 x + 1, & x \neq n\pi \\ 4, & \sin x = 0 \text{ \& } x \neq n\pi \\ 5, & x \in \phi \\ 5, & x \in \phi \\ 4, & x \in \phi \\ 5, & 2 = 2 \text{ (True)} \end{cases}$$

$$= \sin^2 x + 1$$

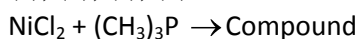
Hence, $g\{f(x)\} = \sin^2 x + 1$

$$\lim_{x \rightarrow 0} g\{f(x)\} = \lim_{x \rightarrow 0} (\sin^2 x + 1) = 1 + 0 = 1$$

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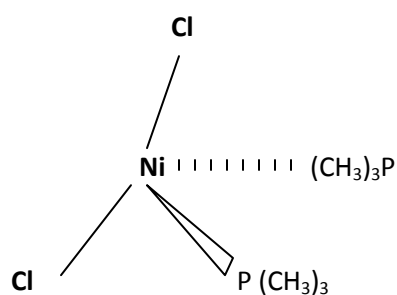
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5. (a), (b), (c), (d)



From elemental composition, empirical/molecular formula = $[\text{NiCl}_2 ((\text{CH}_3)_3\text{P})_2]$.

Since it has no isomeric forms, complex must be tetrahedral.



Magnetic moment: Ni^{2+} ($3d^8$) and sp^3 hybridization indicate presence of two unpaired electrons, hence, $\mu = \sqrt{8} = 3.82 \text{ BM}$

6. (a)

$(\text{CH}_3)_3\text{CCl}$ is more reactive since I^- is a better leaving group than Cl^- .