

Physics 2 – Summer Session 2009

Quiz # 1

Question 1

Let $\mathbf{A} = \mathbf{i} + 3\mathbf{j}$ and $\mathbf{B} = \mathbf{i} + 2\mathbf{k}$. $\mathbf{C} = \mathbf{A} \times \mathbf{B}$ is given by

- (a) \mathbf{i}
- (b) $\mathbf{i} + 3\mathbf{j} + 2\mathbf{k}$
- (c) $3\mathbf{j} + 2\mathbf{k}$
- (d) $6\mathbf{i} - 2\mathbf{j} + -3\mathbf{k}$
- (e) none of the above

$$(\mathbf{i} + 3\mathbf{j}) \times (\mathbf{i} + 2\mathbf{k}) = (\mathbf{i} \times \mathbf{i}) + 2(\mathbf{i} \times \mathbf{k}) + 3(\mathbf{j} \times \mathbf{i}) + 6(\mathbf{j} \times \mathbf{k}) = 0 + 2(-\mathbf{j}) + 3(-\mathbf{k}) + 6(\mathbf{i}) \\ = 6\mathbf{i} - 2\mathbf{j} + -3\mathbf{k} \rightarrow \text{Correct answer is (d)}$$

Question 2

A coin and a wedding ring have the same mass and radius. When placed at the top of an inclined plane, which object reaches the bottom of the inclined plane first?

- (a) the coin
- (b) the ring
- (c) the two objects reach the bottom at the same time
- (d) not enough information to answer this question

The ring has a higher moment of inertia, thus more of its energy is taken up by rotational kinetical energy, therefore it will have less translational kinetical energy, therefore it will move down the incline slower than the coin \rightarrow Correct answer is (a)

Question 3

An ice skater is in a fast spin with her arms held tightly to her body. When she extends her arms, which of the following statements is not true

- (a) She increases her moment of inertia
- (b) She decreases her angular speed
- (c) Her moment of inertia remains constant
- (d) Her total angular momentum remains constant
- (e) (c) and (d)

Moment of inertia increases. The angular momentum remains constant, and the angular speed decreases. \rightarrow Correct answer is (c)

Question 4

A weight W swings from a hook in the ceiling by a light string of length L . The tension in the string is T . When the string makes an angle θ with the vertical, the net torque about the hook is

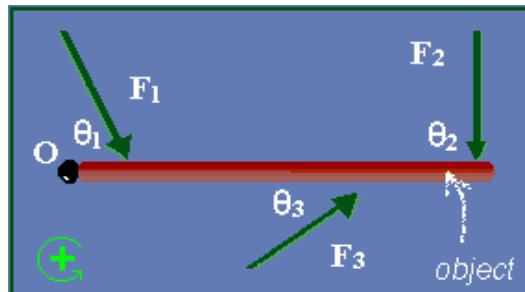
- (a) WL
- (b) $(W-T)L$
- (c) TL
- (d) $WL\cos\theta$
- (e) $WL\sin\theta$

The tension causes no torque since it acts along the string. The component of weight perpendicular to the string causes a torque. This component is equal to $W\sin\theta$.

→ **Correct answer is (e)**

Question 5

The figure shows an object with several forces acting on it. The pivot point is at O .



$F_1 = 10 \text{ N}$ and is at a distance of 0.25 m from O . $\theta_1 = 80^\circ$.

$F_2 = 7 \text{ N}$ and is at a distance of 1.25 m from O . $\theta_2 = 90^\circ$.

$F_3 = 12 \text{ N}$ and is at a distance of 0.60 m from O . $\theta_3 = 40^\circ$.

The magnitude of the net torque is

- (a) 1.7 Nm
- (b) 15.8 Nm
- (c) 6.6 Nm
- (d) 18 Nm
- (e) 61 Nm

$$\tau = F_1 L_1 \sin\theta_1 - F_3 L_3 \sin\theta_3 + F_2 L_2 \sin\theta_2 = 10 \cdot 0.25 \sin 80^\circ \text{ Nm} - 12 \cdot 0.6 \sin 40^\circ \text{ Nm} + 7 \cdot 1.25 \sin 90^\circ \text{ Nm}$$

$$\tau = 2.46 \text{ Nm} - 4.62 \text{ Nm} + 8.75 \text{ Nm} = 6.59 \text{ Nm} \rightarrow \text{Correct answer is (c)}$$

Question 6

A circular disk of mass M and radius R is rotating with angular velocity ω about its vertical axis. When two small objects each of mass m are gently placed on the rim of the disk, the angular velocity of the ring becomes (note: $I_{\text{disk}} = \frac{1}{2} MR^2$)

- (a) $M\omega/(M+4m)$
- (b) $M\omega/(M+2m)$
- (c) $M\omega/(\frac{1}{2} M+4m)$
- (d) $m\omega/(M+4m)$
- (e) $m\omega/(M+2m)$

Angular momentum is conserved.

Initial Angular momentum = $\frac{1}{2} MR^2\omega$

Final Angular momentum = $(\frac{1}{2} MR^2 + 2mR^2) \omega'$

Setting the two equal to each other, and canceling out a factor of R^2 :

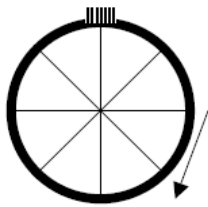
$\frac{1}{2} M \omega = (\frac{1}{2} M + 2m) \omega'$, which can be solved as $\omega' = M\omega/(M+4m)$

→ **Correct answer is (a)**

Question 7

A wheel rotates in the direction shown at 1 revolution per second. It is brought to a stop in 1 second by friction applied through a block at the top of the wheel. What is the magnitude of the angular accelerations in units of rad/sec^2 .

- (a) 2π
- (b) π
- (c) 2
- (d) 1



Motion with constant angular acceleration: $\alpha = \Delta\omega/\Delta t$

$\Delta\omega = 1 \text{ rev}/\text{sec} = 2\pi \text{ rad}/\text{sec}$

$\Delta t = 1 \text{ sec}$

$\alpha = \Delta\omega/\Delta t = 2\pi \text{ rad}/\text{sec}^2$ → **Correct answer is (a)**