

APOLLO

Rigid body mechanics

HL

Physics

First assessment 2025

12 questions | questions

7. A system of moment of inertia I rotates from rest about a given axis. The angular acceleration α of the system is constant.

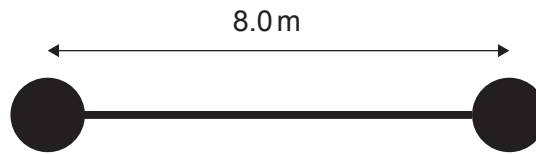
What is the change in angular momentum when the system has made four complete rotations about the given axis?

- A. $2I\sqrt{2\pi\alpha}$
- B. $4I\sqrt{\pi\alpha}$
- C. $2I\sqrt{2\alpha}$
- D. $4I\sqrt{\alpha}$

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8. Two small spheres each of mass 10 kg are 8.0 m apart and connected by a rod of negligible mass. This system rotates about an axis halfway along the rod and at right angles to it.



What is the moment of inertia of the system?

- A. 160 kg m^2
- B. 320 kg m^2
- C. 640 kg m^2
- D. 1280 kg m^2

6. A wheel, initially at rest, rolls without slipping down an incline for 4.0 s. The final angular velocity of the wheel is $5\pi \text{ rad s}^{-1}$.

How many revolutions did the wheel complete?

- A. 5
- B. 10
- C. 15
- D. 30

7. What is the unit of angular impulse?

- A. Ns
- B. Nm
- C. Nm s^{-1}
- D. Nm s

8. A car of total mass M is travelling with a constant speed v . Each of the four wheels of the car has a mass m and a radius R and rolls without slipping.

The moment of inertia of each wheel is $I = \frac{1}{2}mR^2$.

What is $\frac{\text{sum of the rotational kinetic energy of all four wheels}}{\text{translational kinetic energy of the car}}$?

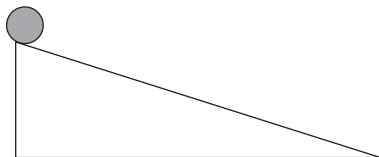
- A. $\frac{m}{2M}$
- B. $\frac{m}{M}$
- C. $\frac{2m}{M}$
- D. $\frac{4m}{M}$

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Turn over
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7. A solid cylinder of mass m and radius r is released from rest on an inclined plane. The cylinder rolls without slipping.

The moment of inertia of the cylinder is $\frac{1}{2}mr^2$. The speed when it reaches the bottom of the inclined plane is v .



What is the vertical height from which the cylinder was released?

- A. $\frac{v^2}{g}$
- B. $\frac{3v^2}{4g}$
- C. $\frac{v^2}{2g}$
- D. $\frac{v^2}{4g}$

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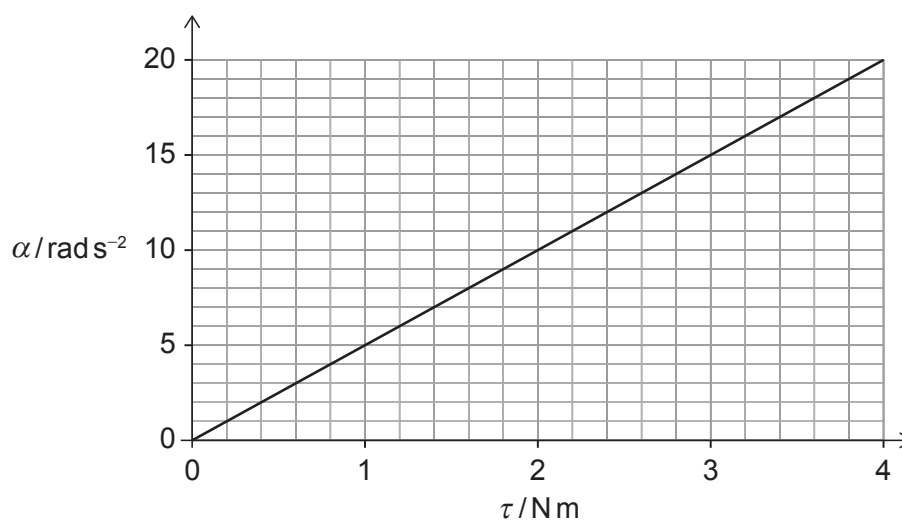
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8. Two spheres, X and Y, are spinning with the same rotational kinetic energy. The moment of inertia of X is I_X and that of Y is I_Y .

What is $\frac{\text{angular momentum of X}}{\text{angular momentum of Y}}$?

- A. $\sqrt{\frac{I_X}{I_Y}}$
- B. $\sqrt{\frac{I_Y}{I_X}}$
- C. $\frac{I_X}{I_Y}$
- D. $\frac{I_Y}{I_X}$

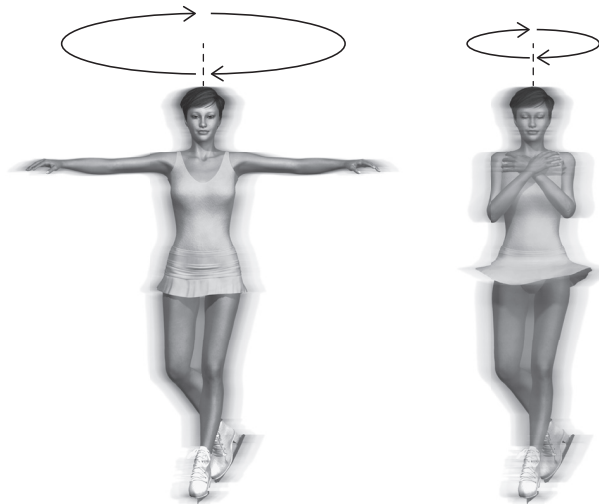
7. The graph shows how the angular acceleration α of a flywheel varies with torque τ applied to the flywheel.



What is the moment of inertia of the flywheel?

- A. 0.20 kg m^2
- B. 5.0 kg m^2
- C. 40 kg m^2
- D. 80 kg m^2

7. An ice skater is spinning with their arms extended in a fixed position at a constant angular velocity. The ice skater then quickly pulls their arms closer to their body. Frictional effects are negligible.



Three statements are made about the ice skater's motion.

- I. The angular momentum of the ice skater remains constant.
- II. The rotational kinetic energy of the ice skater remains constant.
- III. The net torque acting on the ice skater is zero.

Which of the statements are correct?

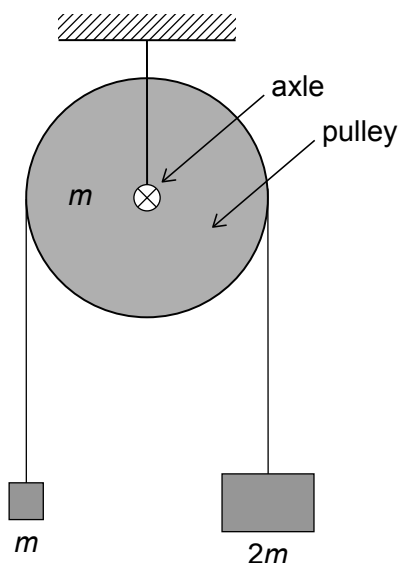
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

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6. Two blocks of mass m and $2m$ are connected with a string that goes over a pulley of mass m .

diagram not to scale



When the blocks are released, the pulley turns about the axle as the blocks move. The string does not slip relative to the pulley. The radius of the pulley is r and its moment of inertia about the axle is $\frac{mr^2}{2}$.

- (a) Show that the acceleration a of the blocks is given by $a = \frac{2g}{7}$. [3]

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- (b) Suggest whether the angular momentum of the pulley–blocks system is conserved. [1]

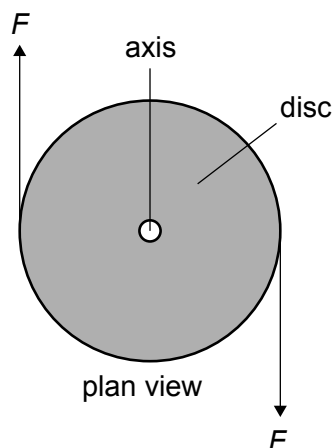
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4. A disc of mass M and radius R is on a horizontal frictionless table. Two equal and opposite forces, each of magnitude F , act on the disc. The moment of inertia of the disc about its axis is $\frac{1}{2}MR^2$.



What is the angular acceleration of the disc?

- A. 0
- B. $\frac{F}{MR}$
- C. $\frac{2F}{MR}$
- D. $\frac{4F}{MR}$

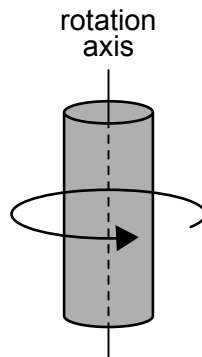
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7. A cylinder of mass M and radius R rotates at constant angular speed ω about an axis through its centre. The rotational kinetic energy of the cylinder is K .

The moment of inertia of the cylinder is $\frac{1}{2}MR^2$.



A second cylinder has mass $2M$, radius $2R$ and rotates with angular speed 2ω .

What is the rotational kinetic energy of the second cylinder?

- A. $8K$
- B. $16K$
- C. $32K$
- D. $64K$

Turn over

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