

Past-paper walk-through

Newton's Third Law ■ 2.3

eXercise

Questions in this set

- 2026 Q2

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 2

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Two small disks, R and S, are on a straight, horizontal track.

At time $t = 0$, Disk R of mass m_0 is located at position $x = 0$. Disk R is initially moving with speed v_0 in the $+x$ -direction. Disk S of mass $3m_0$ is initially at rest, as shown in the top view in Figure 1. Frictional forces are negligible.

At $t = t_1$, the disks collide. Immediately after the collision, Disk R moves with speed $\frac{1}{2}v_0$ in the $-x$ -direction.

[Figure 1 (Top View): A horizontal dashed track with two disks. On the left, a smaller shaded disk labeled m_0 ("Disk R") has an arrow above it labeled v_0 pointing right (in the $+x$ -direction, with a $+x$ axis arrow shown above). On the right, a larger open disk labeled $3m_0$ ("Disk S") is labeled $v = 0$ above it. Note: Figure not drawn to scale.]

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(a) The momentum-vector diagram in Figure 2 represents the momentums of Disk R and Disk S before the collision.

[Figure 2: Two rows, each with a horizontal dashed number-line-style axis (light vertical tick marks along it) crossing a vertical axis at a central dot. Top row labeled "Disk R": a solid arrow starts at the central dot and points right, labeled with the heading "Momentum Before Collision" above both rows. Bottom row labeled "Disk S": just a dot with no arrow, labeled " $p = 0$ " above it.]

Draw arrows on Figure 3 to represent the momentum vectors of Disk R and Disk S after the collision.

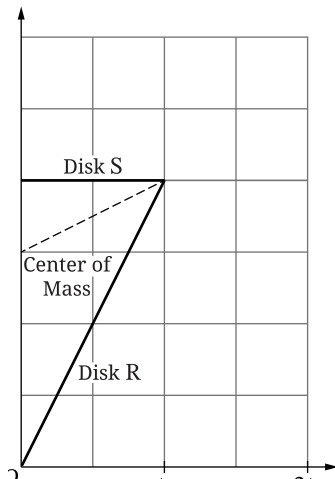
- Each arrow must start on, and point away from, each dot.
- If the momentum of either disk is zero, write " $p = 0$ " next to the dot.

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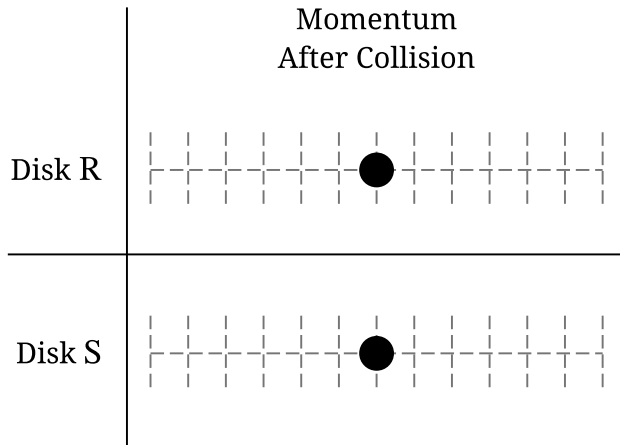
- Draw the length of each arrow to represent the magnitude of each momentum, consistent with the scale used in Figure 2.

[Figure 3: Same style as Figure 2 but blank — two rows each with a horizontal dashed axis and a central dot, headed “Momentum After Collision”, one row labeled “Disk R” and one row labeled “Disk S”, for the student to draw arrows on.]

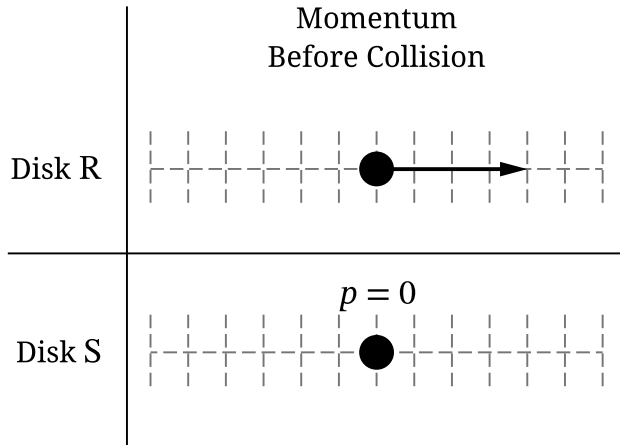
Question 2



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(b) Starting with conservation of linear momentum, **derive** an expression for the kinetic energy of Disk S immediately after the collision. Express your final answer in

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terms of m_0 , v_0 , and physical constants, as appropriate. Begin your derivation by writing the fundamental physics principle or an equation from the reference information.

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(c) The graph shown in Figure 4 represents the positions x as functions of time t from $t = 0$ until $t = t_1$ for each of the following:

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- Disk R
- Disk S
- The center of mass of the two-disk system

On the graph shown in Figure 4, **draw** three lines that represent the positions x of Disk R, Disk S, and the center of mass of the two-disk system as functions of t from $t = t_1$ to $t = 2t_1$. Distinctly **label** each line.

[Figure 4: A position (x , vertical axis) vs. time (t , horizontal axis) grid. From $t = 0$ to $t = t_1$, three straight lines rise from the origin O : the steepest line (largest slope) is labeled "Disk S", a shallower line is labeled "Center of Mass" (shown as a dashed line), and the shallowest line is labeled "Disk R". The horizontal axis is marked with tick values t_1 and $2t_1$ (blank beyond t_1 for the student to continue the lines).]

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(d) During the collision, the magnitudes of the changes in momentum of Disk R and Disk S are $|\Delta p_R|$ and $|\Delta p_S|$, respectively.

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Indicate whether $|\Delta p_R|$ is greater than, less than, or equal to $|\Delta p_S|$ by writing one of the following.

- $|\Delta p_R| > |\Delta p_S|$ - $|\Delta p_R| < |\Delta p_S|$ - $|\Delta p_R| = |\Delta p_S|$

Briefly **justify** your response by referencing a fundamental physics principle.