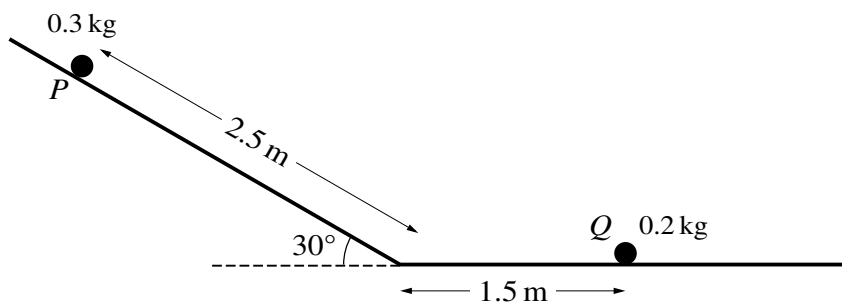


7



(a) It is given that the horizontal plane is smooth and that, after the collision, P continues moving in the same direction, with speed 2 m s^{-1} .

Find the speed of Q after the collision. [5]

[illegible]

9709 Mathematics Paper 4 - Momentum

Topical questions | 34 questions

1. Question part 2/3 | 9709 May-June 2020 P4 V1 Q7

- (b) It is given instead that the horizontal plane is rough and that when P and Q collide, they coalesce and move with speed 1.2 m s^{-1} .

Find the coefficient of friction between P and the horizontal plane.

[5]

[illegible]

Topical questions | 34 questions

Additional Page

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

[illegible]

Topical questions | 34 questions

2. Question part 1/2 | 9709 May-June 2020 P4 V2 Q4

- 4** Small smooth spheres A and B , of equal radii and of masses 4 kg and 2 kg respectively, lie on a smooth horizontal plane. Initially B is at rest and A is moving towards B with speed 10 m s^{-1} . After the spheres collide A continues to move in the same direction but with half the speed of B .

(a) Find the speed of B after the collision. [2]

[illegible]

A third small smooth sphere C , of mass 1 kg and with the same radius as A and B , is at rest on the plane. B now collides directly with C . After this collision B continues to move in the same direction but with one third the speed of C .

(b) Show that there is another collision between A and B . [3]

[illegible]

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Topical questions | 34 questions

2. Question part 2/2 | 9709 May-June 2020 P4 V2 Q4

[illegible]

(c) A and B coalesce during this collision.

Find the total loss of kinetic energy in the system due to the three collisions. [5]

[illegible]

Topical questions | 34 questions

1 Particles P of mass m kg and Q of mass 0.2 kg are free to move on a smooth horizontal plane. P is projected at a speed of 2 m s^{-1} towards Q which is stationary. After the collision P and Q move in opposite directions with speeds of 0.5 m s^{-1} and 1 m s^{-1} respectively.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Topical questions | 34 questions

1 A particle B of mass 5 kg is at rest on a smooth horizontal table. A particle A of mass 2.5 kg moves on the table with a speed of 6 m s^{-1} and collides directly with B . In the collision the two particles coalesce.

- [illegible]

- [illegible]

9709 Mathematics Paper 4 - Momentum

Topical questions | 34 questions

5. Question | 9709 Oct-Nov 2020 P4 V2 Q1

- 1** Two particles P and Q , of masses 0.2 kg and 0.5 kg respectively, are at rest on a smooth horizontal plane. P is projected towards Q with speed 2 m s^{-1} .

(a) Write down the momentum of P . [1]

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- (b)** After the collision P continues to move in the same direction with speed 0.3 m s^{-1} .

Find the speed of Q after the collision. [2]

[illegible]

Topical questions | 34 questions

4 Two small smooth spheres A and B , of equal radii and of masses 4 kg and $m\text{ kg}$ respectively, lie on a smooth horizontal plane. Initially, sphere B is at rest and A is moving towards B with speed 6 m s^{-1} . After the collision A moves with speed 1.5 m s^{-1} and B moves with speed 3 m s^{-1} .

Find the two possible values of the loss of kinetic energy due to the collision. [6]

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Topical questions | 34 questions

7. Question | 9709 Feb-March 2021 P4 V2 Q1

- 1** Two particles P and Q of masses 0.2 kg and 0.3 kg respectively are free to move in a horizontal straight line on a smooth horizontal plane. P is projected towards Q with speed 0.5 m s^{-1} . At the same instant Q is projected towards P with speed 1 m s^{-1} . Q comes to rest in the resulting collision.

Find the speed of P after the collision.

[3]

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Topical questions | 34 questions

8. Question | 9709 May-June 2021 P4 V1 Q3

- 3** Three particles P , Q and R , of masses 0.1 kg , 0.2 kg and 0.5 kg respectively, are at rest in a straight line on a smooth horizontal plane. Particle P is projected towards Q at a speed of 5 m s^{-1} . After P and Q collide, P rebounds with speed 1 m s^{-1} .

(a) Find the speed of Q immediately after the collision with P . [3]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

Q now collides with R . Immediately after the collision with Q , R begins to move with speed $V \text{ m s}^{-1}$.

- (b) Given that there is no subsequent collision between P and Q , find the greatest possible value of V . [3]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Topical questions | 34 questions

1 Particles P of mass 0.4 kg and Q of mass 0.5 kg are free to move on a smooth horizontal plane. P and Q are moving directly towards each other with speeds 2.5 m s^{-1} and 1.5 m s^{-1} respectively. After P and Q collide, the speed of Q is twice the speed of P .

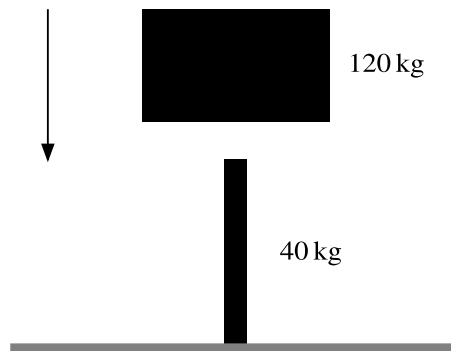
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Topical questions | 34 questions

2 Two small smooth spheres A and B , of equal radii and of masses km kg and m kg respectively, where $k > 1$, are free to move on a smooth horizontal plane. A is moving towards B with speed 6 m s^{-1} and B is moving towards A with speed 2 m s^{-1} . After the collision A and B coalesce and move with speed 4 m s^{-1} .

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

[illegible]



(a) Calculate the speed with which the combined post and object moves immediately after the impact. [2]

Calculate the distance the post is driven into the ground. [3]

[illegible]

Topical questions | 34 questions

1 Small smooth spheres A and B , of equal radii and of masses 5 kg and 3 kg respectively, lie on a smooth horizontal plane. Initially B is at rest and A is moving towards B with speed 8.5 m s^{-1} . The spheres collide and after the collision A continues to move in the same direction but with a quarter of the speed of B .

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- This image shows a full page of white paper with ten horizontal dashed lines, evenly spaced from top to bottom. The lines are thin and black, typical of handwriting practice paper. There are no margins, text, or other markings on the page.

- [illegible]

Topical questions | 34 questions

1 Two particles P and Q , of masses 0.3 kg and 0.2 kg respectively, are at rest on a smooth horizontal plane. P is projected at a speed of 4 m s^{-1} directly towards Q . After P and Q collide, Q begins to move with a speed of 3 m s^{-1} .

- [illegible]

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Topical questions | 34 questions

14. Question | 9709 Oct-Nov 2022 P4 V1 Q2

- 2 Small smooth spheres A and B , of equal radii and of masses 6 kg and 2 kg respectively, lie on a smooth horizontal plane. Initially A is moving towards B with speed 5 m s^{-1} and B is moving towards A with speed 3 m s^{-1} . After the spheres collide, both A and B move in the same direction and the difference in the speeds of the spheres is 2 m s^{-1} .

Find the loss of kinetic energy of the system due to the collision.

[5]

[illegible]

Topical questions | 34 questions

15. Question part 1/2 | 9709 Oct-Nov 2022 P4 V2 Q6

- 6** Three particles A , B and C of masses 0.3 kg , 0.4 kg and $m\text{ kg}$ respectively lie at rest in a straight line on a smooth horizontal plane. The distance between B and C is 2.1 m . A is projected directly towards B with speed 2 m s^{-1} . After A collides with B the speed of A is reduced to 0.6 m s^{-1} , still moving in the same direction.

(a) Show that the speed of B after the collision is 1.05 m s^{-1} . [2]

After the collision between A and B , B moves directly towards C . Particle B now collides with C . After this collision, the two particles coalesce and have a combined speed of 0.5 ms^{-1} .

(b) Find m . [2]

[illegible]

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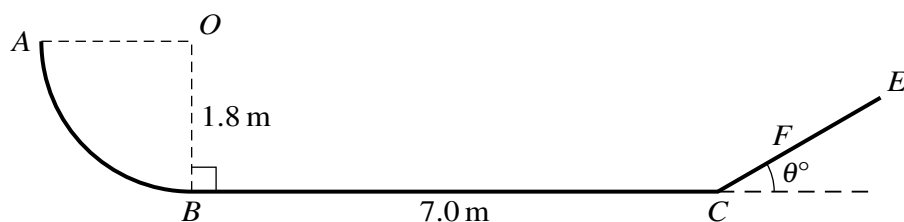
Topical questions | 34 questions

15. Question part 2/2 | 9709 Oct-Nov 2022 P4 V2 Q6

- (c) Find the time that it takes, from the instant when B and C collide, until A collides with the combined particle. [5]

[illegible]

7



A particle P of mass 0.5 kg is released from rest at A . Particle P collides with a particle Q of mass 0.1 kg which is at rest at B . Immediately after the collision, the speed of P is 4 m s^{-1} in the direction BC . You should assume that P is moving horizontally when it collides with Q .

- (a)** Show that the speed of Q immediately after the collision is 10 m s^{-1} . [4]

[illegible]

16. Question part 2/4 | 9709 Feb-March 2023 P4 V2 Q7

When Q reaches C , it collides with a particle R of mass 0.4 kg which is at rest at C . The two particles coalesce. The combined particle comes instantaneously to rest at F . You should assume that there is no instantaneous change in speed as the combined particle leaves C , nor when it passes through C again as it returns down the slope.

(b) Given that the distance CF is 0.4 m , find the value of θ . [4]

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9709 Mathematics Paper 4 - Momentum

Topical questions | 34 questions

16. Question part 3/4 | 9709 Feb-March 2023 P4 V2 Q7

(c) Find the distance from B at which P collides with the combined particle.

[5]

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for letter height. The entire page is otherwise blank, with no margins, text, or other markings.

Topical questions | 34 questions

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Topical questions | 34 questions

17. Question | 9709 May-June 2023 P4 V1 Q1

- 1** Two particles P and Q , of masses m kg and 0.3 kg respectively, are at rest on a smooth horizontal plane. P is projected at a speed of 5 m s^{-1} directly towards Q . After P and Q collide, P moves with a speed of 2 m s^{-1} in the same direction as it was originally moving.

(a) Find, in terms of m , the speed of Q after the collision. [2]

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After this collision, Q moves directly towards a third particle R , of mass 0.6 kg , which is at rest on the plane. Q is brought to rest in the collision with R , and R begins to move with a speed of 1.5 m s^{-1} .

(b) Find the value of m . [2]

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Topical questions | 34 questions

2 Two particles A and B , of masses 3.2 kg and 2.4 kg respectively, lie on a smooth horizontal table. A moves towards B with a speed of $v\text{ ms}^{-1}$ and collides with B , which is moving towards A with a speed of 6 ms^{-1} . In the collision the two particles come to rest.

- [illegible]

- [illegible]

Topical questions | 34 questions

1 Two particles P and Q , of masses 0.1 kg and 0.4 kg respectively, are free to move on a smooth horizontal plane. Particle P is projected with speed 4 m s^{-1} towards Q which is stationary. After P and Q collide, the speeds of P and Q are equal.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Topical questions | 34 questions

5 A particle A of mass 0.5 kg is projected vertically upwards from horizontal ground with speed 25 m s^{-1} .

- [illegible]

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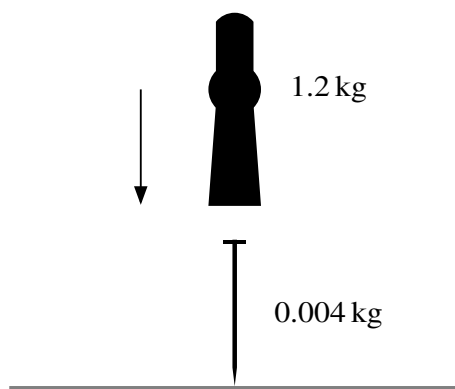
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Topical questions | 34 questions

20. Question part 2/2 | 9709 Oct-Nov 2023 P4 V2 Q5

- (c) Find the time interval between A and B reaching the ground. You should assume that A does not bounce when it reaches the ground. [4]

[illegible]



(a) Calculate v , giving your answer as an exact fraction. [2]

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Find the constant force resisting the motion. [3]

[illegible]

Topical questions | 34 questions

7 A particle P of mass 0.2 kg is projected vertically upwards from horizontal ground with speed 25 ms^{-1} .

[illegible][illegible]

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Topical questions | 34 questions

22. Question part 2/3 | 9709 May-June 2024 P4 V1 Q7

When P reaches the ground it rebounds back directly upwards with half of the speed that it had immediately before hitting the ground.

- (c) Find the height above the ground at which P and Q next collide. [6]

[illegible]

If you use the following page to complete the answer to any question, the question number must be clearly shown.

[illegible]

Topical questions | 34 questions

6 Three particles A , B and C of masses 5 kg, 1 kg and 2 kg respectively lie at rest in that order on a straight smooth horizontal track XYZ . Initially A is at X , B is at Y and C is at Z . Particle A is projected towards B with a speed of 6 ms^{-1} and at the same instant C is projected towards B with a speed of $v \text{ ms}^{-1}$. In the subsequent motion, A collides and coalesces with B to form particle D . Particle D then collides and coalesces with C to form particle E and E moves towards Z .

- [illegible]

- [illegible]

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(c) It is given that the distance XY is 36 m and the distance YZ is 98 m.

(i) Find the time between the two collisions. [4]

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(ii) Find the time between the instant that A is projected from X and the instant that E reaches Z . [1]

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Topical questions | 34 questions

24. Question | 9709 May-June 2024 P4 V3 Q1

- 1** Two particles P and Q of masses 0.2 kg and 0.5 kg respectively are at rest on a smooth horizontal plane. Particle P is projected with a speed 6 m s^{-1} directly towards Q . After P and Q collide, P moves with a speed of 1 m s^{-1} .

Find the two possible speeds of Q after the collision.

[3]

[illegible]

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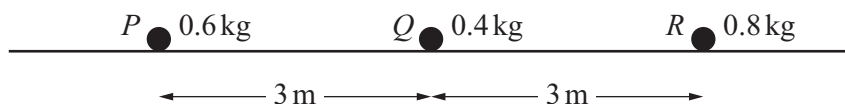
25. Question | 9709 Oct-Nov 2024 P4 V3 Q4

- 4 Two particles, A and B , of masses 3 kg and 6 kg respectively, lie on a smooth horizontal plane. Initially, B is at rest and A is moving towards B with speed 8 m s^{-1} . After A and B collide, A moves with speed 2 m s^{-1} .

Find the greater of the two possible total losses of kinetic energy due to the collision. [6]

[illegible]

5



Three particles P , Q and R , of masses 0.6 kg , 0.4 kg and 0.8 kg respectively, are at rest in a straight line on a smooth horizontal plane. The distance from P to Q is 3 m , and the distance from Q to R is also 3 m (see diagram). P is projected directly towards Q with speed 3 m s^{-1} . After P and Q collide, P continues to move in the same direction with speed 1.5 m s^{-1} .

- (a)** Find the speed of Q after the collision. [2]

[illegible]

In the subsequent collision between Q and R , these particles coalesce.

- (b)** Find the speed of the combined particle after this collision. [1]

[illegible]

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Topical questions | 34 questions

26. Question part 2/2 | 9709 Feb-March 2025 P4 V2 Q5



- (c) Find the time that it takes from when P is initially projected until the instant at which P collides with the combined particle. [4]

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Topical questions | 34 questions

5 When a particle P of mass m kg has speed u m s⁻¹, its momentum is 4 N s and its kinetic energy is 16 J.

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[illegible]

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Topical questions | 34 questions

28. Question | 9709 May-June 2025 P4 V2 Q2

- 2 Two particles P and Q , of masses 0.2 kg and 0.1 kg respectively, are free to move in a straight line on a smooth horizontal plane. P is projected towards Q with speed 5 ms^{-1} . At the same instant, Q is projected away from P with speed 2 ms^{-1} . When P collides with Q , the particles coalesce.

Find the kinetic energy lost during the collision.

[4]

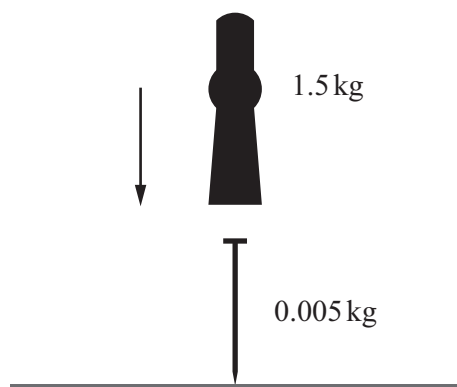
Topical questions | 34 questions

- (a) Find the two possible values of u . [3]

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- [illegible]

2



(a) Calculate the speed with which the combined hammerhead and nail move immediately after the impact. Give your answer correct to 3 decimal places. [2]

There is a constant force resisting the motion of magnitude 25 000 N.

(b) Calculate the distance the nail is driven into the wood. [3]

[illegible]

Topical questions | 34 questions

2 Two particles, P and Q , of masses 3 kg and 5 kg respectively, are at rest on a smooth horizontal plane. P is projected at a speed of 4 m s^{-1} directly towards Q . After P and Q collide, P has speed 1 m s^{-1} .

[illegible]

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9709 Mathematics Paper 4 - Momentum

Topical questions | 34 questions

32. Question | 9709 Oct-Nov 2025 P4 V1 Q6

- 6** A particle A of mass 2.5 kg is released from rest from the top of a smooth plane, which makes an angle of $\sin^{-1} 0.2$ with the horizontal. The particle A collides 2 seconds later with a particle B , of mass 3 kg , which is moving up a line of greatest slope of the plane. The speed of B immediately before the collision is 3.5 m s^{-1} . Immediately after the collision, B has a velocity of 0.5 m s^{-1} down the plane.

Find the distance A moves up the plane after the collision. [6]

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Topical questions | 34 questions

6 Particle P of mass m kg and particle Q of mass 2 kg are free to move on a smooth horizontal plane. P and Q are moving directly towards each other with speeds u m s⁻¹ and $3u$ m s⁻¹ respectively. P and Q collide and the direction of motion of each particle is reversed by the collision. Immediately after the collision the speed of P is $\frac{u}{3}$ m s⁻¹.

- [illegible]

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Topical questions | 34 questions

33. Question part 2/2 | 9709 Oct-Nov 2025 P4 V3 Q6



Q subsequently hits a vertical wall which is perpendicular to the direction of motion of Q . The speed of Q after the impact with the wall is a quarter of its speed before the impact with the wall. There are no further collisions between P and Q .

(b) Given that m is an integer, determine the largest possible value of m . [4]

[illegible]

Topical questions | 34 questions

6 Two particles A and B of masses km and m respectively, where k and m are constants, are free to move in a straight line on a smooth horizontal plane. Particle A is projected towards B with speed $2u$ and at the same instant B is projected towards A with speed u .

It is given that 35% of the total kinetic energy is lost in the collision. Find, in terms of u , the speed of B after the collision. [8]

[illegible]

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Topical questions | 34 questions

34. Question part 2/3 | 9709 Oct-Nov 2025 P4 V5 Q6

[illegible]



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