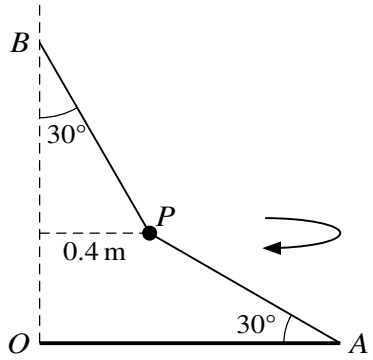
1. Question | 9709 May-June 2016 P5 V2 Q6

6



OA is a rod which rotates in a horizontal circle about a vertical axis through O. A particle P of mass 0.2 kg is attached to the mid-point of a light inextensible string. One end of the string is attached to the rod at A and the other end of the string is attached to a point B on the axis. It is given that $OA = OB$, angle OAP = angle $OBP = 30°$, and P is 0.4 m from the axis. The rod and the particle rotate together about the axis with P in the plane OAB (see diagram).

(i) Calculate the tensions in the two parts of the string when the speed of P is $1.2\,\text{m}\,\text{s}^{-1}$. [6]

The angular speed of the rod is increased to $5\,\text{rad}\,\text{s}^{-1}$, and it is given that the system now rotates with angle OAP = angle $OBP = 60°$.

(ii) Show that the tension in the part AP of the string is zero. [6]

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2. Question part 1/2 | 9709 Feb-March 2017 P5 V2 Q7

7 One end of a light elastic string of natural length 0.6 m and modulus of elasticity 24 N is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.4 kg which hangs in equilibrium vertically below O.

(i) Calculate the extension of the string. [2]

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P is projected vertically downwards from the equilibrium position with speed $5\,\text{m}\,\text{s}^{-1}$.

(ii) Calculate the distance P travels before it is first at instantaneous rest. [4]

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2. Question part 2/2 | 9709 Feb-March 2017 P5 V2 Q7

When P is first at instantaneous rest a stationary particle of mass 0.4 kg becomes attached to P.

(iii) Find the greatest speed of the combined particle in the subsequent motion. [4]

3. Question | 9709 May-June 2017 P5 V1 Q1

1 A particle is projected with speed $20\,\text{m}\,\text{s}^{-1}$ at an angle of 60° above the horizontal. Calculate the time after projection when the particle is descending at an angle of 40° below the horizontal. [4]

4. Question part 1/2 | 9709 May-June 2017 P5 V1 Q4

4 A particle is projected from a point O on horizontal ground. The initial components of the velocity of the particle are $10\,\text{m s}^{-1}$ horizontally and $15\,\text{m s}^{-1}$ vertically. At time t s after projection, the horizontal and vertically upwards displacements of the particle from O are x m and y m respectively.

(i) Express x and y in terms of t, and hence find the equation of the trajectory of the particle. [4]

4. Question part 2/2 | 9709 May-June 2017 P5 V1 Q4

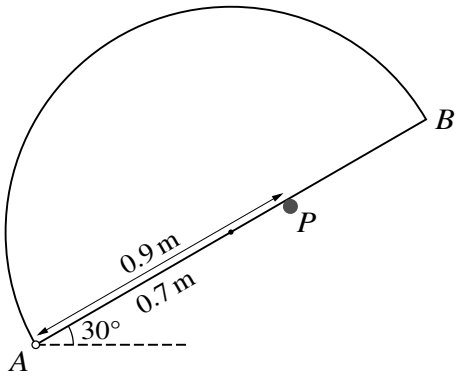
The horizontal ground is at the top of a vertical cliff. The point O is at a distance d m from the edge of the cliff. The particle is projected towards the edge of the cliff and does not strike the ground before it passes over the edge of the cliff.

(ii) Show that d is less than 30. [2]

(iii) Find the value of x when the particle is 14 m below the level of O. [2]

5. Question part 1/2 | 9709 May-June 2017 P5 V1 Q5

5



A uniform semicircular lamina of radius 0.7 m and weight 14 N has diameter AB. The lamina is in a vertical plane with A freely pivoted at a fixed point. The straight edge AB rests against a small smooth peg P above the level of A. The angle between AB and the horizontal is 30° and AP = 0.9 m (see diagram).

(i) Show that the magnitude of the force exerted by the peg on the lamina is 7.12 N, correct to 3 significant figures. [4]

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5. Question part 2/2 | 9709 May-June 2017 P5 V1 Q5

(ii) Find the angle with the horizontal of the force exerted by the pivot on the lamina at A. [3]

6. Question part 1/2 | 9709 May-June 2017 P5 V1 Q6

6 A particle P of mass 0.15 kg is attached to one end of a light elastic string of natural length 0.4 m and modulus of elasticity 12 N. The other end of the string is attached to a fixed point A. The particle P moves in a horizontal circle which has its centre vertically below A, with the string inclined at $\theta°$ to the vertical and $AP = 0.5$ m.

(i) Find the angular speed of P and the value of θ. [5]

(ii) Calculate the difference between the elastic potential energy stored in the string and the kinetic energy of P. [4]

7. Question | 9709 May-June 2017 P5 V2 Q1

1 A particle P of mass 0.2 kg moves with speed 4 m s^{-1} and angular speed 5 rad s^{-1} in a horizontal circle on a smooth surface. P is attached to one end of a light elastic string of natural length 0.6 m. The other end of the string is attached to the point on the surface which is the centre of the circular motion of P.

(i) Find the radius of this circle. [1]

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(ii) Find the modulus of elasticity of the string. [4]

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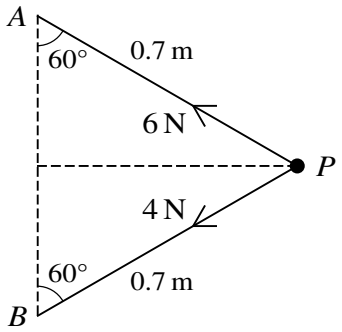
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8. Question part 1/2 | 9709 May-June 2017 P5 V2 Q2

2



The ends of two light inextensible strings of length 0.7 m are attached to a particle P. The other ends of the strings are attached to two fixed points A and B which lie in the same vertical line with A above B. The particle P moves in a horizontal circle which has its centre at the mid-point of AB. Both strings are inclined at 60° to the vertical. The tension in the string attached to A is 6 N and the tension in the string attached to B is 4 N (see diagram).

(i) Find the mass of P. [2]

8. Question part 2/2 | 9709 May-June 2017 P5 V2 Q2

(ii) Calculate the speed of P. [3]

9. Question part 1/2 | 9709 May-June 2017 P5 V2 Q5

5 A particle of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.8 m and modulus of elasticity 6 N. The other end of the string is attached to a fixed point O. The particle is projected vertically downwards from O with initial speed $2\,\text{m}\,\text{s}^{-1}$.

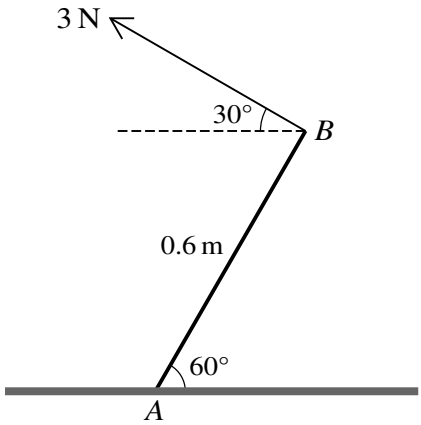
(i) Calculate the greatest speed of the particle during its descent. [5]

9. Question part 2/2 | 9709 May-June 2017 P5 V2 Q5

(ii) Find the greatest distance of the particle below O. [3]

10. Question part 1/2 | 9709 May-June 2017 P5 V2 Q6

6



The end A of a non-uniform rod AB of length 0.6 m and weight 8 N rests on a rough horizontal plane, with AB inclined at 60° to the horizontal. Equilibrium is maintained by a force of magnitude 3 N applied to the rod at B. This force acts at 30° above the horizontal in the vertical plane containing the rod (see diagram).

(i) Find the distance of the centre of mass of the rod from A. [2]

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10. Question part 2/2 | 9709 May-June 2017 P5 V2 Q6

The 3 N force is removed, and the rod is held in equilibrium by a force of magnitude P N applied at B, acting in the vertical plane containing the rod, at an angle of 30° below the horizontal.

(ii) Calculate P. [2]

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In one of the two situations described, the rod AB is in limiting equilibrium.

(iii) Find the coefficient of friction at A. [4]

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11. Question part 1/2 | 9709 May-June 2017 P5 V2 Q7

7 A particle P is projected from a point O with speed V m s^{-1}. At time t s after projection the horizontal and vertically upwards displacements of P from O are x m and y m respectively. The equation of the trajectory of P is $y = 2x - \frac{25x^2}{V^2}$.

(i) Write down the value of $\tan\theta$, where θ is the angle of projection of P. [1]

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When $t = 4$, P passes through the point A where $x = y = a$.

(ii) Calculate V and a. [5]

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11. Question part 2/2 | 9709 May-June 2017 P5 V2 Q7

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(iii) Find the direction of motion of P when it passes through A. [3]

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12. Question part 1/2 | 9709 May-June 2017 P5 V3 Q2

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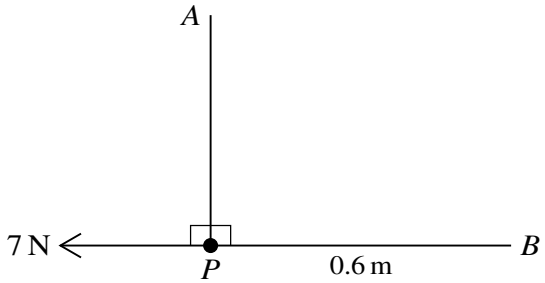


Fig. 1

One end of a light inextensible string is attached to a fixed point A. The other end of the string is attached to a particle P of mass m kg which hangs vertically below A. The particle is also attached to one end of a light elastic string of natural length 0.25 m. The other end of this string is attached to a point B which is 0.6 m from P and on the same horizontal level as P. Equilibrium is maintained by a horizontal force of magnitude 7 N applied to P (see Fig. 1).

(i) Calculate the modulus of elasticity of the elastic string. [2]

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12. Question part 2/2 | 9709 May-June 2017 P5 V3 Q2

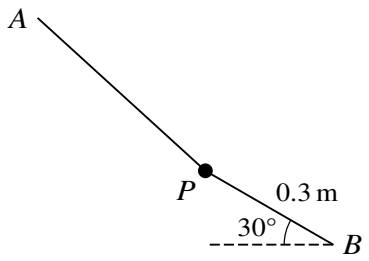


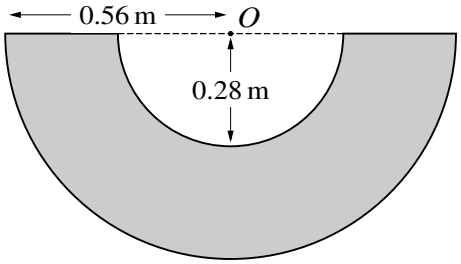
Fig. 2

P is released from rest by removing the 7 N force. In its subsequent motion P first comes to instantaneous rest at a point where $BP = 0.3$ m and the elastic string makes an angle of 30° with the horizontal (see Fig. 2).

(ii) Find the value of m. [4]

13. Question part 1/2 | 9709 May-June 2017 P5 V3 Q3

3



An object is made from a uniform solid hemisphere of radius 0.56 m and centre O by removing a hemisphere of radius 0.28 m and centre O. The diagram shows a cross-section through O of the object.

(i) Calculate the distance of the centre of mass of the object from O. [4]

[The volume of a hemisphere is $\frac{2}{3}\pi r^3$.]

13. Question part 2/2 | 9709 May-June 2017 P5 V3 Q3

The object has weight 24 N. A uniform hemisphere H of radius 0.28 m is placed in the hollow part of the object to create a non-uniform hemisphere with centre O. The centre of mass of the non-uniform hemisphere is 0.15 m from O.

(ii) Calculate the weight of H. [3]

14. Question part 1/2 | 9709 May-June 2017 P5 V3 Q6

6 A particle P of mass 0.15 kg is attached to one end of a light elastic string of natural length 0.4 m and modulus of elasticity 12 N. The other end of the string is attached to a fixed point A. The particle P moves in a horizontal circle which has its centre vertically below A, with the string inclined at $\theta°$ to the vertical and $AP = 0.5$ m.

(i) Find the angular speed of P and the value of θ. [5]

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(ii) Calculate the difference between the elastic potential energy stored in the string and the kinetic energy of P. [4]

15. Question part 1/2 | 9709 May-June 2017 P5 V3 Q7

7 A particle P of mass 0.5 kg is at rest at a point O on a rough horizontal surface. At time $t = 0$, where t is in seconds, a horizontal force acting in a fixed direction is applied to P. At time t s the magnitude of the force is $0.6t^2$ N and the velocity of P away from O is v m s^{-1}. It is given that P remains at rest at O until $t = 0.5$.

(i) Calculate the coefficient of friction between P and the surface, and show that

$$\frac{\mathrm{d}v}{\mathrm{d}t} = 1.2t^2 - 0.3 \quad \text{for } t > 0.5. \qquad [3]$$

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(ii) Express v in terms of t for $t > 0.5$. [3]

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(iii) Find the displacement of P from O when $t = 1.2$. [3]

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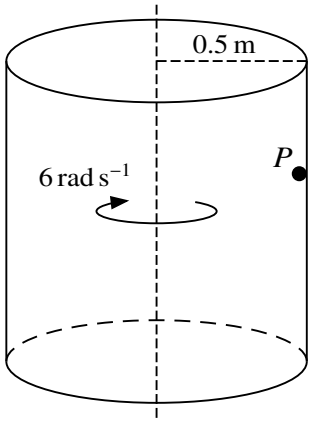
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16. Question | 9709 Oct-Nov 2017 P5 V1 Q1

1



A hollow cylinder with a rough inner surface has radius 0.5 m. A particle P of mass 0.4 kg is in contact with the inner surface of the cylinder. The particle and cylinder rotate together with angular speed 6 rad s^{-1} about the vertical axis of the cylinder, so that the particle moves in a horizontal circle (see diagram). Given that P is about to slip downwards, find the coefficient of friction between P and the surface of the cylinder. [4]

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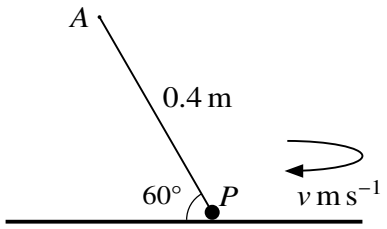
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17. Question part 1/2 | 9709 Oct-Nov 2017 P5 V1 Q3

3



One end of a light inextensible string of length 0.4 m is attached to a fixed point A which is above a smooth horizontal surface. A particle P of mass 0.6 kg is attached to the other end of the string. P moves in a circle on the surface with constant speed v m s^{-1}, with the string taut and making an angle of 60° with the horizontal (see diagram).

(i) Given that $v = 0.5$, calculate the magnitude of the force that the surface exerts on P. [4]

17. Question part 2/2 | 9709 Oct-Nov 2017 P5 V1 Q3

(ii) Find the greatest possible value of v for which P remains in contact with the surface. [3]

18. Question part 1/2 | 9709 Oct-Nov 2017 P5 V1 Q4

4 A particle P is projected with speed $25\,\text{m}\,\text{s}^{-1}$ at an angle of $30°$ above the horizontal from a point O on horizontal ground. At time t s after projection the horizontal and vertically upwards displacements of P from O are x m and y m respectively.

(i) Express x and y in terms of t and hence show that the equation of the trajectory of P is

$$y = \frac{x}{\sqrt{3}} - \frac{4x^2}{375}.$$ [4]

18. Question part 2/2 | 9709 Oct-Nov 2017 P5 V1 Q4

(ii) Find the horizontal distance between the two points at which P is 5 m above the ground. [3]

19. Question part 1/2 | 9709 Oct-Nov 2017 P5 V1 Q7

7 A particle P of mass 0.2 kg is released from rest at a point O on a rough plane inclined at 60° to the horizontal, and travels down a line of greatest slope. The coefficient of friction between P and the plane is 0.3. A force of magnitude $0.6x$ N acts on P in the direction PO, where x m is the displacement of P from O.

(i) Show that $v\frac{\mathrm{d}v}{\mathrm{d}x} = 5\sqrt{3} - 1.5 - 3x$, where $v\,\mathrm{m\,s^{-1}}$ is the velocity of P at a displacement x m from O. [3]

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(ii) Find the value of x for which P reaches its maximum velocity, and calculate this maximum velocity. [4]

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(iii) Calculate the magnitude of the acceleration of P immediately after it has first come to instantaneous rest. [4]

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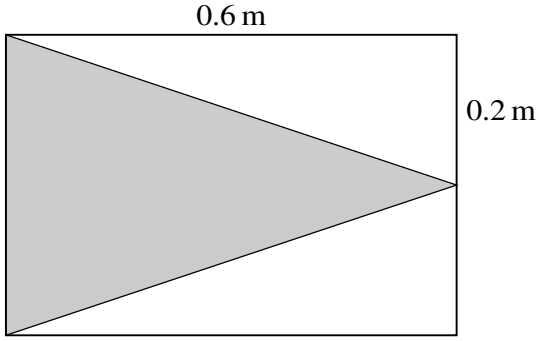
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20. Question | 9709 Oct-Nov 2017 P5 V2 Q1

1 A particle P of mass 0.2 kg is released from rest at a point O on a smooth horizontal surface. A horizontal force of magnitude te^{-v} N directed away from O acts on P, where v m s^{-1} is the velocity of P at time t s after release. Find the velocity of P when $t = 2$. [4]

21. Question | 9709 Oct-Nov 2017 P5 V2 Q2

2



A uniform solid cone has height 0.6 m and base radius 0.2 m. A uniform hollow cylinder, open at both ends, has the same dimensions. An object is made by putting the cone inside the cylinder so that the base of the cone coincides with one end of the cylinder (see diagram, which shows a cross-section). The total weight of the object is 60 N and its centre of mass is 0.25 m from the base of the cone. Calculate the weight of the cone. [3]

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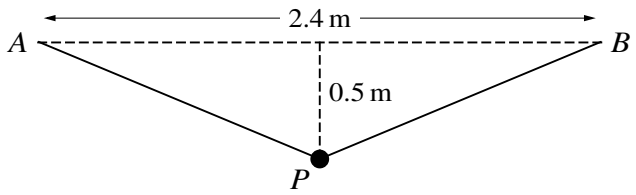
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4



A light elastic string has natural length 2 m and modulus of elasticity 39 N. The ends of the string are attached to fixed points A and B which are at the same horizontal level and 2.4 m apart. A particle P of mass m kg is attached to the mid-point of the string and hangs in equilibrium at a point 0.5 m below AB (see diagram).

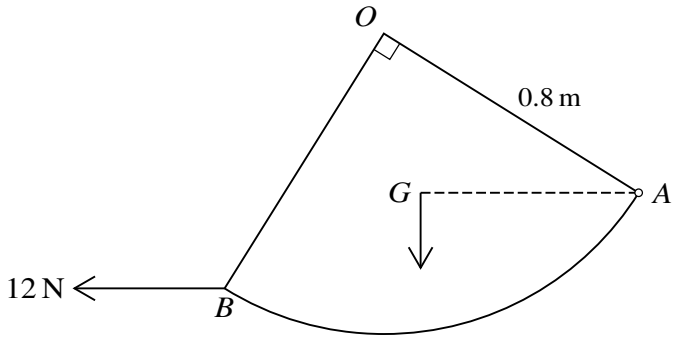
(i) Show that $m = 0.9$. [4]

P is projected vertically downwards from the equilibrium position, and comes to instantaneous rest at a point 1.6 m below AB.

(ii) Calculate the speed of projection of P. [5]

23. Question part 1/2 | 9709 Oct-Nov 2017 P5 V2 Q5

5



OAB is a uniform lamina in the shape of a quadrant of a circle with centre *O* and radius 0.8 m which has its centre of mass at *G*. The lamina is smoothly hinged at *A* to a fixed point and is free to rotate in a vertical plane. A horizontal force of magnitude 12 N acting in the plane of the lamina is applied to the lamina at *B*. The lamina is in equilibrium with *AG* horizontal (see diagram).

(i) Calculate the length *AG*. [3]

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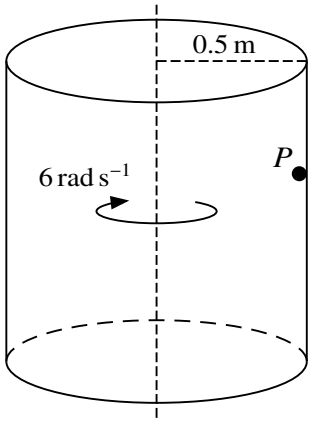
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23. Question part 2/2 | 9709 Oct-Nov 2017 P5 V2 Q5

(ii) Find the weight of the lamina. [5]

24. Question | 9709 Oct-Nov 2017 P5 V3 Q1

1



A hollow cylinder with a rough inner surface has radius 0.5 m. A particle P of mass 0.4 kg is in contact with the inner surface of the cylinder. The particle and cylinder rotate together with angular speed 6 rad s^{-1} about the vertical axis of the cylinder, so that the particle moves in a horizontal circle (see diagram). Given that P is about to slip downwards, find the coefficient of friction between P and the surface of the cylinder. [4]

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25. Question | 9709 Oct-Nov 2017 P5 V3 Q2

2 A small ball is projected from a point 1.5 m above horizontal ground. At a point 9 m above the ground the ball is travelling at 45° above the horizontal and its velocity is $4\ \text{m s}^{-1}$. Find the angle of projection of the ball. [4]

26. Question part 1/2 | 9709 Oct-Nov 2017 P5 V3 Q5

5 One end of a light elastic string of natural length 0.8 m and modulus of elasticity 24 N is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.3 kg. P is projected vertically upwards with speed $4\,\text{m}\,\text{s}^{-1}$ from a position 1.2 m vertically below O.

(i) Calculate the speed of the particle at the position where it is moving with zero acceleration. [5]

26. Question part 2/2 | 9709 Oct-Nov 2017 P5 V3 Q5

(ii) Show that the particle moves 1.2 m while moving upwards with constant deceleration. [3]

27. Question part 1/2 | 9709 Oct-Nov 2017 P5 V3 Q6

6 A solid object consists of a uniform hemisphere of radius 0.4 m attached to a uniform cylinder of radius 0.4 m so that the circumferences of their circular faces coincide. The hemisphere and cylinder each have weight 20 N. The centre of mass of the object lies at the centre O of their common circular face.

(i) Show that the height of the cylinder is 0.3 m. [2]

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A new object is made by cutting the cylinder in half and removing the half not attached to the hemisphere. The cut is perpendicular to the axis of symmetry, so the new object consists of a hemisphere and a cylinder half the height of the original cylinder.

(ii) Find the distance of the centre of mass of the new object from O. [4]

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The new object is placed with its hemispherical part on a rough horizontal surface. The new object is held in equilibrium by a force of magnitude P N acting along its axis of symmetry, which is inclined at 30° to the horizontal.

(iii) Find P. [3]

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28. Question | 9709 Feb-March 2018 P5 V2 Q3

3 A small ball B is connected to one end of a light elastic string of natural length 0.4 m and modulus of elasticity 12 N. The other end of the string is attached to a fixed point A. The ball is projected with speed 1 m s^{-1} vertically downwards from a position 0.4 m vertically below A, and reaches its greatest speed at the point 0.7 m below A.

(i) Show that the mass of B is 0.9 kg. [2]

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(ii) Calculate the greatest speed of B. [4]

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29. Question part 1/2 | 9709 Feb-March 2018 P5 V2 Q4

4 A particle P is projected from a point O on horizontal ground. At the instant t s after projection, the horizontal and vertically upwards displacements of P from O are x m and y m respectively. The equation of the trajectory of P is $y = 3x - 0.05x^2$.

(i) Find the angle of projection and the initial speed of P. [3]

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(ii) Find the coordinates of P at the instant when OP makes an angle of 45° with the horizontal. [2]

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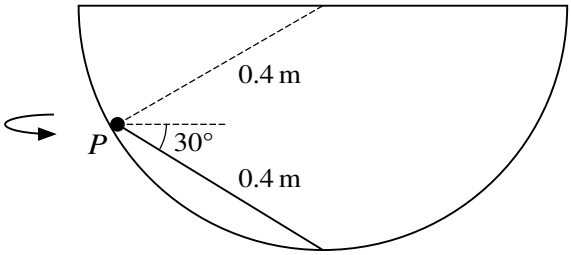
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(iii) For the instant when P is at its greatest height above the ground, calculate this height and the corresponding value of t. [4]

30. Question part 1/2 | 9709 Feb-March 2018 P5 V2 Q5

5



One end of a light inextensible string of length 0.4 m is attached to the lowest point of a hemisphere of radius 0.4 m fixed with its axis vertical. A particle P of mass 0.3 kg is attached to the other end of the string. The string is straight and makes an angle of 30° with the horizontal. P moves on the smooth inner surface of the hemisphere in a horizontal circle (see diagram).

(i) Calculate the smallest possible angular speed of P. [4]

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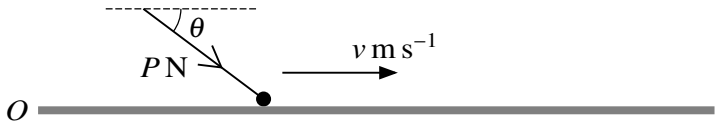
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(ii) Given that the greatest possible tension in the string is 5 N, calculate the greatest possible speed of P. [4]

31. Question part 1/2 | 9709 Feb-March 2018 P5 V2 Q6

6



A small object of mass 0.2 kg rests at a point O on a rough horizontal surface. The coefficient of friction between the object and the surface is 0.5. A force of magnitude P N acting at an angle θ below the horizontal is applied to the object. The velocity of the object is v m s^{-1} away from O at time t s after the force begins to act (see diagram). It is given that $\tan\theta = \frac{3}{4}$ and that $P = 0.4t$ for $0 \leqslant t \leqslant 8$.

(i) Find the value of t when the object starts to move. [3]

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(ii) Show that, when the force is acting and the object is in motion, $\frac{\mathrm{d}v}{\mathrm{d}t} = t - 5$. [2]

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31. Question part 2/2 | 9709 Feb-March 2018 P5 V2 Q6

When $t = 8$ the force of magnitude P N ceases to act.

(iii) Find the distance travelled by the object after $t = 8$ before it comes to rest. [5]

32. Question part 1/5 | 9709 Feb-March 2018 P5 V2 Q7

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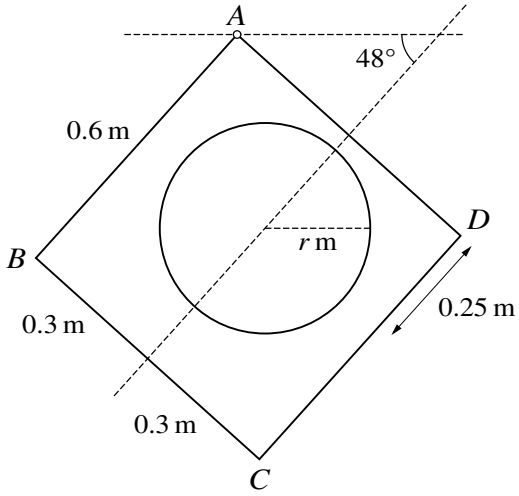


Fig. 1

ABCD is a uniform square lamina with sides of length 0.6 m. A circular hole of radius r m is made in the lamina. The centre of the hole is 0.3 m from *AB* and 0.25 m from *AD*. The lamina is freely suspended at *A* and hangs with the axis of symmetry making an angle of 48° with the horizontal (see Fig. 1).

(i) Show that $r = 0.214$, correct to 3 significant figures. [5]

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32. Question part 2/5 | 9709 Feb-March 2018 P5 V2 Q7

32. Question part 3/5 | 9709 Feb-March 2018 P5 V2 Q7

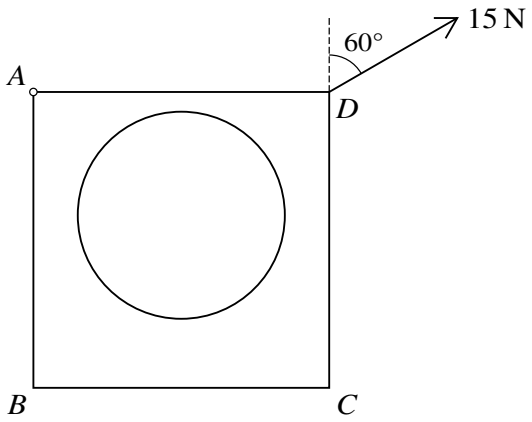


Fig. 2

The lamina is held in equilibrium with AD horizontal by a force of magnitude 15 N acting in the plane of the lamina applied at D. The line of action of this force makes an angle of 60° with the vertical (see Fig. 2).

(ii) Find the weight of the original square lamina, before the hole was made. [4]

32. Question part 4/5 | 9709 Feb-March 2018 P5 V2 Q7

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33. Question | 9709 May-June 2018 P5 V1 Q1

1 A small ball B is projected from a point O on horizontal ground. The initial velocity of B has horizontal and vertically upwards components of $18\,\text{m s}^{-1}$ and $25\,\text{m s}^{-1}$ respectively. For the instant 4 s after projection, find the speed and direction of motion of B. [4]

34. Question part 1/2 | 9709 May-June 2018 P5 V1 Q4

4 A small object is projected from a point O with speed V m s^{-1} at an angle of 45° above the horizontal. At time t s after projection, the horizontal and vertically upwards displacements of the object from O are x m and y m respectively.

(i) Express x and y in terms of t, and hence find the equation of the path. [4]

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The object passes through the point with coordinates (24, 18).

(ii) Find V. [2]

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(iii) The object passes through two points which are 22.5 m above the level of O. Find the values of x for these points. [3]

35. Question part 1/2 | 9709 May-June 2018 P5 V1 Q5

5 A particle P of mass 0.7 kg is attached by a light elastic string to a fixed point O on a smooth plane inclined at an angle of 30° to the horizontal. The natural length of the string is 0.5 m and the modulus of elasticity is 20 N. The particle P is projected up the line of greatest slope through O from a point A below the level of O. The initial kinetic energy of P is 1.8 J and the initial elastic potential energy in the string is also 1.8 J.

(i) Find the distance OA. [2]

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(ii) Find the greatest speed of P in the motion. [6]

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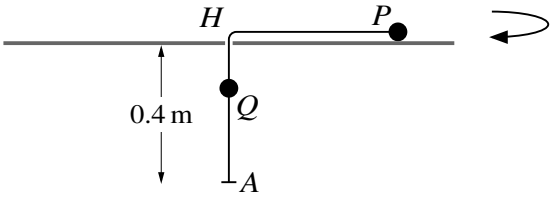
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35. Question part 2/2 | 9709 May-June 2018 P5 V1 Q5

36. Question part 1/2 | 9709 May-June 2018 P5 V1 Q6

6



A particle P of mass 0.2 kg is attached to one end of a light inextensible string of length 0.6 m. The other end of the string is attached to a particle Q of mass 0.3 kg. The string passes through a small hole H in a smooth horizontal surface. A light elastic string of natural length 0.3 m and modulus of elasticity 15 N joins Q to a fixed point A which is 0.4 m vertically below H. The particle P moves on the surface in a horizontal circle with centre H (see diagram).

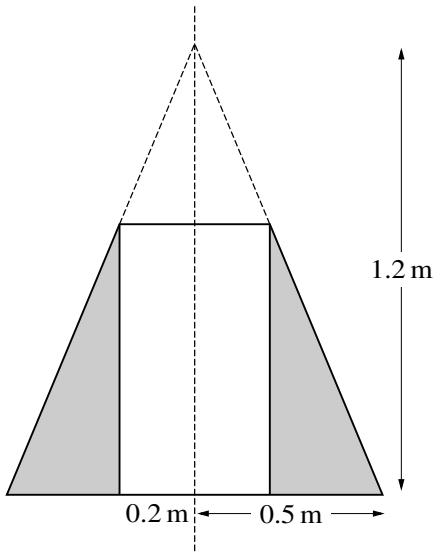
(i) Calculate the greatest possible speed of P for which the elastic string is not extended. [4]

36. Question part 2/2 | 9709 May-June 2018 P5 V1 Q6

(ii) Find the distance HP given that the angular speed of P is $8\,\text{rad}\,\text{s}^{-1}$. [5]

37. Question part 1/3 | 9709 May-June 2018 P5 V1 Q7

7



A uniform solid cone has height 1.2 m and base radius 0.5 m. A uniform object is made by drilling a cylindrical hole of radius 0.2 m through the cone along the axis of symmetry (see diagram).

(i) Show that the height of the object is 0.72 m and that the volume of the cone removed by the drilling is $0.0352\pi\,\text{m}^3$. [4]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$.]

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37. Question part 2/3 | 9709 May-June 2018 P5 V1 Q7

(ii) Find the distance of the centre of mass of the object from its base. [6]

37. Question part 3/3 | 9709 May-June 2018 P5 V1 Q7

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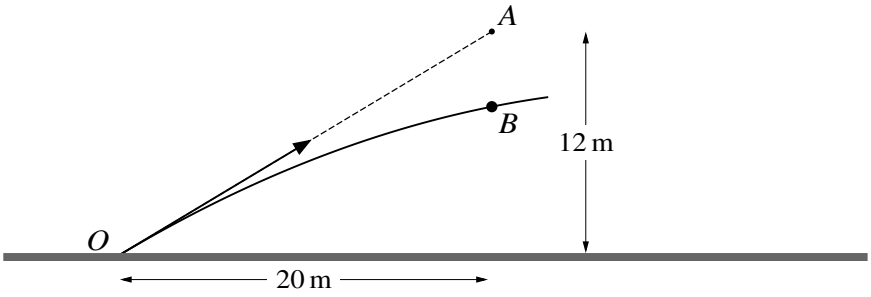
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38. Question | 9709 May-June 2018 P5 V2 Q1

1



A small ball B is projected from a point O on horizontal ground towards a point A 12 m above the ground. 0.9 s after projection B has travelled a horizontal distance of 20 m and is vertically below A (see diagram).

(i) Find the angle and the speed of projection of B. [4]

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(ii) Calculate the distance AB when B is vertically below A. [2]

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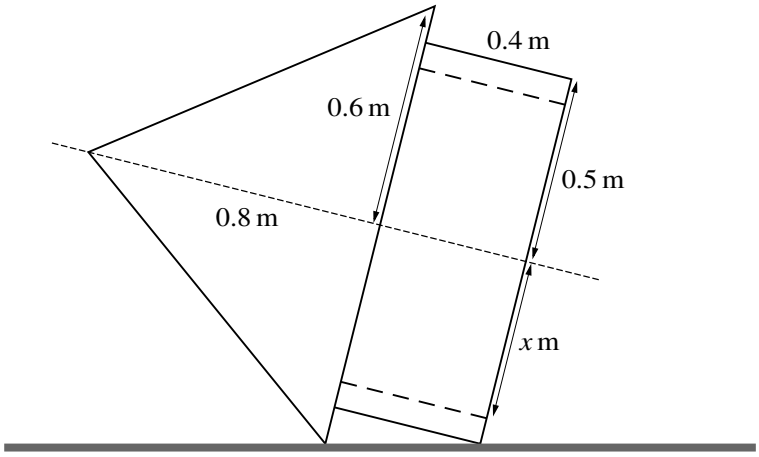
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39. Question | 9709 May-June 2018 P5 V2 Q2

2 One end of a light elastic string is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.4 kg. The string has natural length 0.6 m and modulus of elasticity 24 N. The particle is released from rest at O. Find the two possible values of the distance OP for which the particle has speed $1.5\,\text{m}\,\text{s}^{-1}$. [6]

40. Question part 1/2 | 9709 May-June 2018 P5 V2 Q5

5



A uniform object is made by joining a solid cone of height 0.8 m and base radius 0.6 m and a cylinder. The cylinder has length 0.4 m and radius 0.5 m. The cylinder has a cylindrical hole of length 0.4 m and radius x m drilled through it along the axis of symmetry. A plane face of the cylinder is attached to the base of the cone so that the object has an axis of symmetry perpendicular to its base and passing through the vertex of the cone. The object is placed with points on the base of the cone and the base of the cylinder in contact with a horizontal surface (see diagram). The object is on the point of toppling.

(i) Show that the centre of mass of the object is 0.15 m from the base of the cone. [3]

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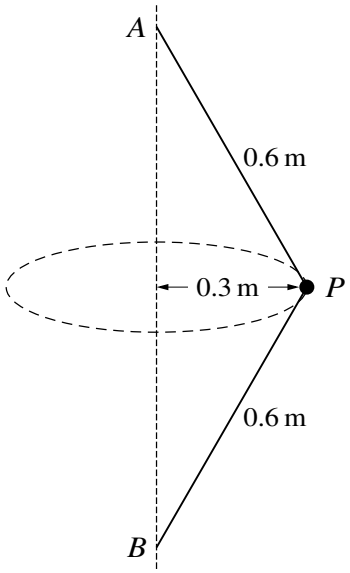
40. Question part 2/2 | 9709 May-June 2018 P5 V2 Q5

(ii) Find x. [4]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$.]

41. Question part 1/2 | 9709 May-June 2018 P5 V2 Q6

6



A particle P of mass 0.2 kg is attached to one end of a light inextensible string of length 0.6 m. The other end of the string is attached to a fixed point A. The particle P is also attached to one end of a second light inextensible string of length 0.6 m, the other end of which is attached to a fixed point B vertically below A. The particle moves in a horizontal circle of radius 0.3 m, which has its centre at the mid-point of AB, with both strings straight (see diagram).

(i) Calculate the least possible angular speed of P. [4]

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41. Question part 2/2 | 9709 May-June 2018 P5 V2 Q6

The string AP will break if its tension exceeds 8 N. The string BP will break if its tension exceeds 5 N.

(ii) Find the greatest possible speed of P. [5]

42. Question part 1/3 | 9709 May-June 2018 P5 V2 Q7

7 A particle P of mass 0.2 kg is released from rest at a point O above horizontal ground. At time t s after its release the velocity of P is v m s^{-1} downwards. A vertically downwards force of magnitude $0.6t$ N acts on P. A vertically upwards force of magnitude $k\mathrm{e}^{-t}$ N, where k is a constant, also acts on P.

(i) Show that $\dfrac{\mathrm{d}v}{\mathrm{d}t} = 10 - 5k\mathrm{e}^{-t} + 3t$. [2]

(ii) Find the greatest value of k for which P does not initially move upwards. [3]

42. Question part 2/3 | 9709 May-June 2018 P5 V2 Q7

(iii) Given that $k = 1$, and that P strikes the ground when $t = 2$, find the height of O above the ground. [5]

42. Question part 3/3 | 9709 May-June 2018 P5 V2 Q7

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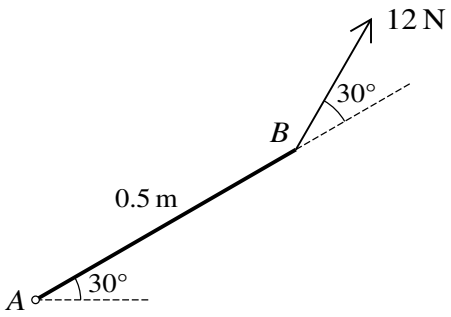
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43. Question | 9709 May-June 2018 P5 V3 Q2

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A non-uniform rod AB of length 0.5 m and weight 8 N is freely hinged to a fixed point at A. The rod makes an angle of 30° with the horizontal with B above the level of A. The rod is held in equilibrium by a force of magnitude 12 N acting in the vertical plane containing the rod at an angle of 30° to AB applied at B (see diagram). Find the distance of the centre of mass of the rod from A. [3]

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44. Question part 1/2 | 9709 May-June 2018 P5 V3 Q3

3 A particle P of mass 0.4 kg is projected horizontally along a smooth horizontal plane from a point O. At time t s after projection the velocity of P is v m s^{-1}. A force of magnitude $0.8t$ N directed away from O acts on P and a force of magnitude $2e^{-t}$ N opposes the motion of P.

(i) Show that $\frac{dv}{dt} = 2t - 5e^{-t}$. [2]

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(ii) Given that $v = 8$ when $t = 1$, express v in terms of t. [3]

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(iii) Find the speed of projection of P. [2]

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45. Question part 1/2 | 9709 May-June 2018 P5 V3 Q5

5 A particle P of mass 0.7 kg is attached by a light elastic string to a fixed point O on a smooth plane inclined at an angle of 30° to the horizontal. The natural length of the string is 0.5 m and the modulus of elasticity is 20 N. The particle P is projected up the line of greatest slope through O from a point A below the level of O. The initial kinetic energy of P is 1.8 J and the initial elastic potential energy in the string is also 1.8 J.

(i) Find the distance OA. [2]

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(ii) Find the greatest speed of P in the motion. [6]

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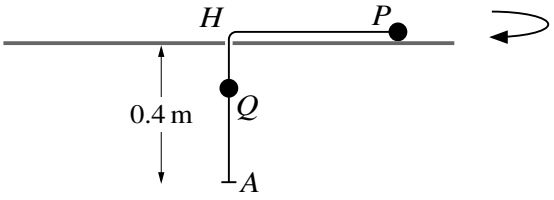
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45. Question part 2/2 | 9709 May-June 2018 P5 V3 Q5

46. Question part 1/2 | 9709 May-June 2018 P5 V3 Q6

6



A particle P of mass 0.2 kg is attached to one end of a light inextensible string of length 0.6 m. The other end of the string is attached to a particle Q of mass 0.3 kg. The string passes through a small hole H in a smooth horizontal surface. A light elastic string of natural length 0.3 m and modulus of elasticity 15 N joins Q to a fixed point A which is 0.4 m vertically below H. The particle P moves on the surface in a horizontal circle with centre H (see diagram).

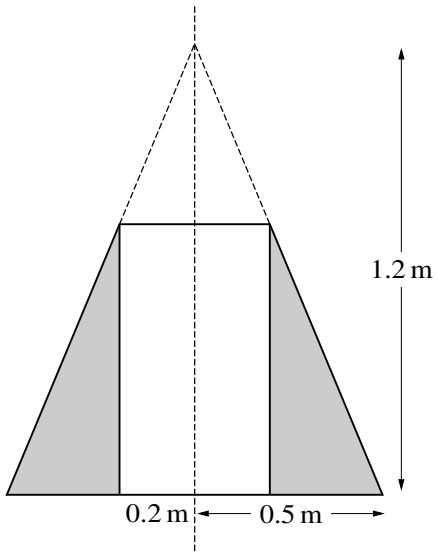
(i) Calculate the greatest possible speed of P for which the elastic string is not extended. [4]

46. Question part 2/2 | 9709 May-June 2018 P5 V3 Q6

(ii) Find the distance HP given that the angular speed of P is $8\,\text{rad}\,\text{s}^{-1}$. [5]

47. Question part 1/3 | 9709 May-June 2018 P5 V3 Q7

7



A uniform solid cone has height 1.2 m and base radius 0.5 m. A uniform object is made by drilling a cylindrical hole of radius 0.2 m through the cone along the axis of symmetry (see diagram).

(i) Show that the height of the object is 0.72 m and that the volume of the cone removed by the drilling is $0.0352\pi\,\text{m}^3$. [4]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$.]

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47. Question part 2/3 | 9709 May-June 2018 P5 V3 Q7

(ii) Find the distance of the centre of mass of the object from its base. [6]

47. Question part 3/3 | 9709 May-June 2018 P5 V3 Q7

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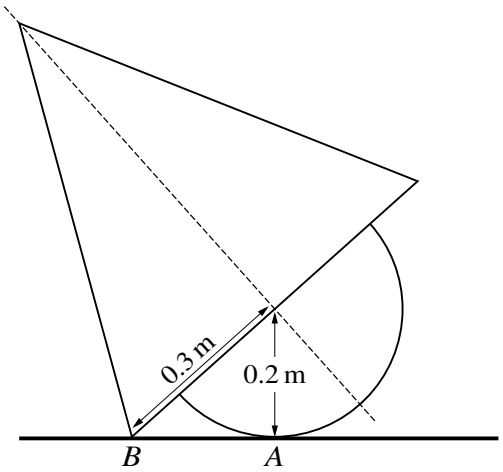
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48. Question | 9709 Oct-Nov 2018 P5 V1 Q1

1 A small ball B is projected with speed $30\,\mathrm{m\,s^{-1}}$ at an angle of $60°$ to the horizontal from a point on horizontal ground. Find the time after projection when the speed of B is $25\,\mathrm{m\,s^{-1}}$ for the second time. [4]

49. Question part 1/2 | 9709 Oct-Nov 2018 P5 V1 Q2

2



A uniform object is made by attaching the base of a solid hemisphere to the base of a solid cone so that the object has an axis of symmetry. The base of the cone has radius 0.3 m, and the hemisphere has radius 0.2 m. The object is placed on a horizontal plane with a point A on the curved surface of the hemisphere and a point B on the circumference of the cone in contact with the plane (see diagram).

(i) Given that the object is on the point of toppling about B, find the distance of the centre of mass of the object from the base of the cone. [3]

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49. Question part 2/2 | 9709 Oct-Nov 2018 P5 V1 Q2

(ii) Given instead that the object is on the point of toppling about A, calculate the height of the cone. [3]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$. The volume of a hemisphere is $\frac{2}{3}\pi r^3$.]

50. Question part 1/2 | 9709 Oct-Nov 2018 P5 V1 Q3

3 A particle P of mass 0.4 kg is attached to a fixed point O by a light elastic string of natural length 0.5 m and modulus of elasticity 20 N. The particle P is released from rest at O.

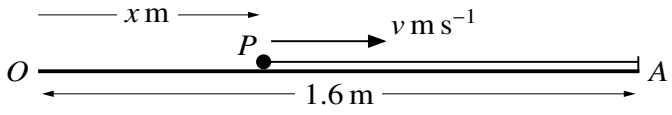
(i) Find the greatest speed of P in the subsequent motion. [4]

50. Question part 2/2 | 9709 Oct-Nov 2018 P5 V1 Q3

(ii) Find the distance below O of the point at which P comes to instantaneous rest. [3]

51. Question part 1/2 | 9709 Oct-Nov 2018 P5 V1 Q4

4



A particle P of mass 0.5 kg is projected along a smooth horizontal surface towards a fixed point A. Initially P is at a point O on the surface, and after projection, P has a displacement from O of x m and velocity v m s^{-1}. The particle P is connected to A by a light elastic string of natural length 0.8 m and modulus of elasticity 16 N. The distance OA is 1.6 m (see diagram). The motion of P is resisted by a force of magnitude $24x^2$ N.

(i) Show that $v\dfrac{\mathrm{d}v}{\mathrm{d}x} = 32 - 40x - 48x^2$ while P is in motion and the string is stretched. [3]

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The maximum value of v is 4.5.

(ii) Find the initial value of v. [5]

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51. Question part 2/2 | 9709 Oct-Nov 2018 P5 V1 Q4

52. Question part 1/2 | 9709 Oct-Nov 2018 P5 V1 Q6

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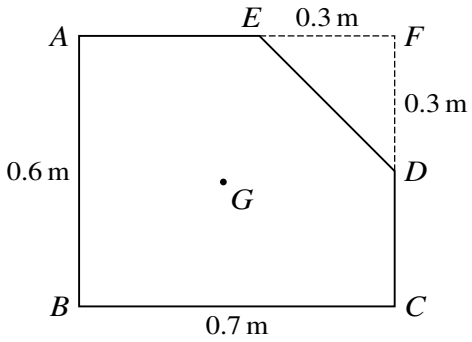


Fig. 1

Fig. 1 shows the cross-section $ABCDE$ through the centre of mass G of a uniform prism. The cross-section consists of a rectangle $ABCF$ from which a triangle DEF has been removed; $AB = 0.6$ m, $BC = 0.7$ m and $DF = EF = 0.3$ m.

(i) Show that the distance of G from BC is 0.276 m, and find the distance of G from AB. [5]

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52. Question part 2/2 | 9709 Oct-Nov 2018 P5 V1 Q6

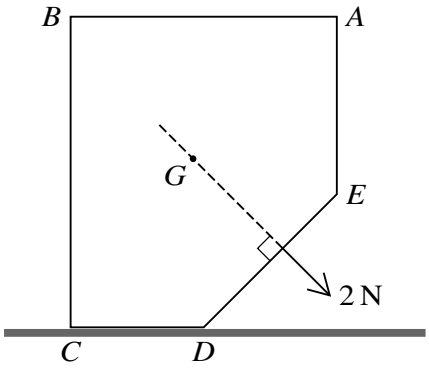


Fig. 2

The prism is placed with CD on a rough horizontal surface. A force of magnitude 2 N acting in the plane of the cross-section is applied to the prism. The line of action of the force passes through G and is perpendicular to DE (see Fig. 2). The prism is on the point of toppling about the edge through D.

(ii) Calculate the weight of the prism. [3]

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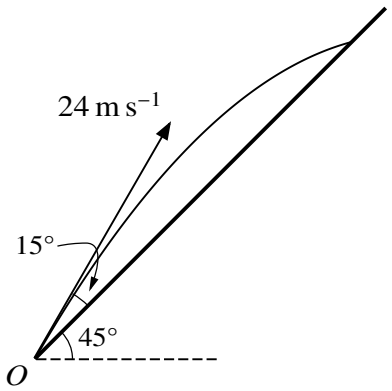
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53. Question part 1/3 | 9709 Oct-Nov 2018 P5 V1 Q7

7



A small object is projected with speed 24 m s^{-1} from a point O at the foot of a plane inclined at 45° to the horizontal. The angle of projection of the object is 15° above a line of greatest slope of the plane (see diagram). At time t s after projection, the horizontal and vertically upwards displacements of the object from O are x m and y m respectively.

(i) Express x and y in terms of t, and hence find the value of t for the instant when the object strikes the plane. [4]

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(ii) Express the vertical height of the object above the plane in terms of t and hence find the greatest vertical height of the object above the plane. [5]

53. Question part 3/3 | 9709 Oct-Nov 2018 P5 V1 Q7

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54. Question | 9709 Oct-Nov 2018 P5 V2 Q1

1 A small ball B is projected with speed $38\,\mathrm{m\,s^{-1}}$ at an angle of 30° to the horizontal from a point on horizontal ground. Find the speed of B when the path of B makes an angle of 20° above the horizontal. [3]

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55. Question part 1/2 | 9709 Oct-Nov 2018 P5 V2 Q2

2 A uniform solid object is made by attaching a cone to a cylinder so that the circumferences of the base of the cone and a plane face of the cylinder coincide. The cone and the cylinder each have radius 0.3 m and height 0.4 m.

(i) Calculate the distance of the centre of mass of the object from the vertex of the cone. [4]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$.]

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The object has weight W N and is placed with its plane circular face on a rough horizontal surface. A force of magnitude kW N acting at 30° to the upward vertical is applied to the vertex of the cone. The object does not slip.

(ii) Find the greatest possible value of k for which the object does not topple. [3]

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56. Question part 1/2 | 9709 Oct-Nov 2018 P5 V2 Q4

4 A small object is projected horizontally with speed V m s^{-1} from a point O above horizontal ground. At time t s after projection, the horizontal and vertically upwards displacements of the object from O are x m and y m respectively.

(i) Express x and y in terms of t and hence show that the equation of the path of the object is $y = -\frac{5x^2}{V^2}$. [3]

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The object passes through points with coordinates $(a, -a)$ and $(a^2, -16a)$, where a is a positive constant.

(ii) Find the value of a. [3]

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(iii) Given that the object strikes the ground at the point where $x = 5a$, find the height of O above the ground . [2]

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57. Question part 1/2 | 9709 Oct-Nov 2018 P5 V2 Q5

5 A particle P of mass 0.7 kg is attached to a fixed point O by a light elastic string of natural length 0.6 m and modulus of elasticity 15 N. The particle P is projected vertically downwards from the point A, 0.8 m vertically below O. The initial speed of P is $2\,\text{m}\,\text{s}^{-1}$.

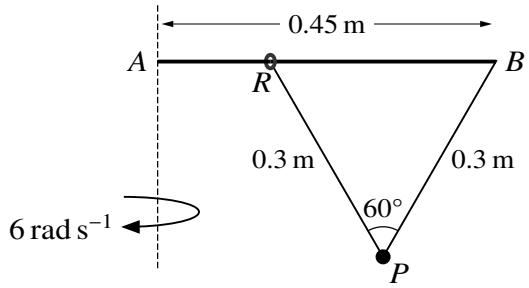
(i) Find the distance below A of the point at which P comes to instantaneous rest. [4]

57. Question part 2/2 | 9709 Oct-Nov 2018 P5 V2 Q5

(ii) Find the greatest speed of P in the motion. [4]

58. Question part 1/3 | 9709 Oct-Nov 2018 P5 V2 Q7

7



A rough horizontal rod AB of length 0.45 m rotates with constant angular velocity 6 rad s^{-1} about a vertical axis through A. A small ring R of mass 0.2 kg can slide on the rod. A particle P of mass 0.1 kg is attached to the mid-point of a light inextensible string of length 0.6 m. One end of the string is attached to R and the other end of the string is attached to B, with angle $RPB = 60°$ (see diagram). R and P move in horizontal circles as the system rotates. R is in limiting equilibrium.

(i) Show that the tension in the portion PR of the string is 1.66 N, correct to 3 significant figures. [5]

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58. Question part 2/3 | 9709 Oct-Nov 2018 P5 V2 Q7

(ii) Find the coefficient of friction between the ring and the rod. [5]

58. Question part 3/3 | 9709 Oct-Nov 2018 P5 V2 Q7

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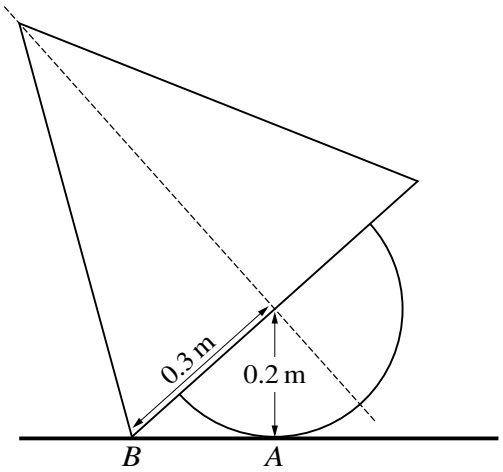
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59. Question | 9709 Oct-Nov 2018 P5 V3 Q1

1 A small ball B is projected with speed $30\,\text{m s}^{-1}$ at an angle of $60°$ to the horizontal from a point on horizontal ground. Find the time after projection when the speed of B is $25\,\text{m s}^{-1}$ for the second time. [4]

60. Question part 1/2 | 9709 Oct-Nov 2018 P5 V3 Q2

2



A uniform object is made by attaching the base of a solid hemisphere to the base of a solid cone so that the object has an axis of symmetry. The base of the cone has radius 0.3 m, and the hemisphere has radius 0.2 m. The object is placed on a horizontal plane with a point A on the curved surface of the hemisphere and a point B on the circumference of the cone in contact with the plane (see diagram).

(i) Given that the object is on the point of toppling about B, find the distance of the centre of mass of the object from the base of the cone. [3]

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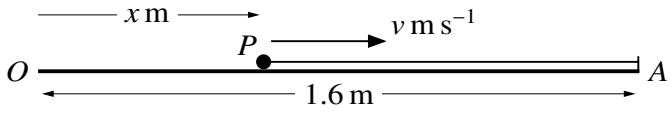
60. Question part 2/2 | 9709 Oct-Nov 2018 P5 V3 Q2

(ii) Given instead that the object is on the point of toppling about A, calculate the height of the cone. [3]

[The volume of a cone is $\frac{1}{3}\pi r^2 h$. The volume of a hemisphere is $\frac{2}{3}\pi r^3$.]

61. Question part 1/2 | 9709 Oct-Nov 2018 P5 V3 Q4

4



A particle P of mass 0.5 kg is projected along a smooth horizontal surface towards a fixed point A. Initially P is at a point O on the surface, and after projection, P has a displacement from O of x m and velocity v m s^{-1}. The particle P is connected to A by a light elastic string of natural length 0.8 m and modulus of elasticity 16 N. The distance OA is 1.6 m (see diagram). The motion of P is resisted by a force of magnitude $24x^2$ N.

(i) Show that $v\dfrac{\mathrm{d}v}{\mathrm{d}x} = 32 - 40x - 48x^2$ while P is in motion and the string is stretched. [3]

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The maximum value of v is 4.5.

(ii) Find the initial value of v. [5]

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61. Question part 2/2 | 9709 Oct-Nov 2018 P5 V3 Q4

62. Question part 1/2 | 9709 Oct-Nov 2018 P5 V3 Q5

5 A particle P of mass 0.1 kg is attached to one end of a light inextensible string of length 0.5 m. The other end of the string is attached to a fixed point A. The particle P moves in a circle which has its centre O on a smooth horizontal surface 0.3 m below A. The tension in the string has magnitude T N and the magnitude of the force exerted on P by the surface is R N.

(i) Given that the speed of P is $1.5\,\text{m}\,\text{s}^{-1}$, calculate T and R. [4]

62. Question part 2/2 | 9709 Oct-Nov 2018 P5 V3 Q5

(ii) Given instead that $T = R$, calculate the angular speed of P. [4]

63. Question part 1/2 | 9709 Oct-Nov 2018 P5 V3 Q6

6

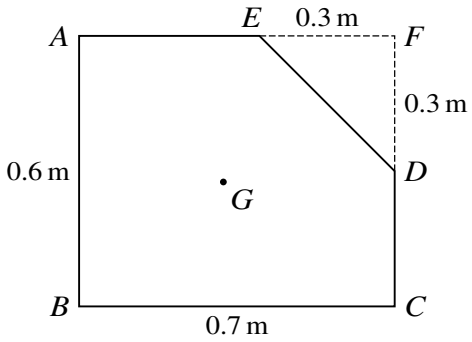


Fig. 1

Fig. 1 shows the cross-section $ABCDE$ through the centre of mass G of a uniform prism. The cross-section consists of a rectangle $ABCF$ from which a triangle DEF has been removed; $AB = 0.6$ m, $BC = 0.7$ m and $DF = EF = 0.3$ m.

(i) Show that the distance of G from BC is 0.276 m, and find the distance of G from AB. [5]

63. Question part 2/2 | 9709 Oct-Nov 2018 P5 V3 Q6

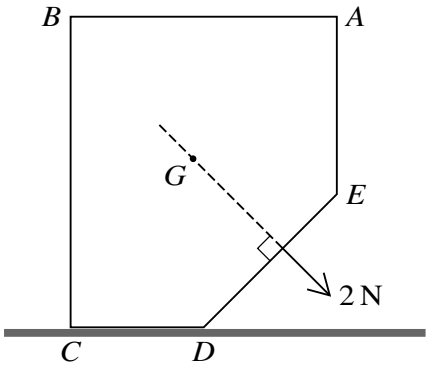


Fig. 2

The prism is placed with CD on a rough horizontal surface. A force of magnitude 2 N acting in the plane of the cross-section is applied to the prism. The line of action of the force passes through G and is perpendicular to DE (see Fig. 2). The prism is on the point of toppling about the edge through D.

(ii) Calculate the weight of the prism. [3]

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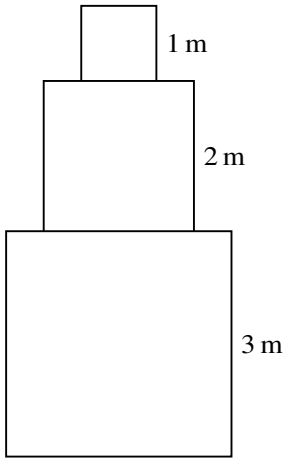
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64. Question part 1/2 | 9709 Feb-March 2019 P5 V2 Q2

2



A uniform object is made by joining together three solid cubes with edges 3 m, 2 m and 1 m. The object has an axis of symmetry, with the cubes stacked vertically and the cube of edge 2 m between the other two cubes (see diagram).

(i) Calculate the distance of the centre of mass of the object above the base of the largest cube. [3]

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The smallest cube is now removed from the object. It is replaced by a heavier uniform cube with 1 m edges which is made of a different material. The centre of mass of the object is now at the base of the 2 m cube.

(ii) Find the ratio of the masses of the two cubes of edge 1 m. [3]

65. Question | 9709 Feb-March 2019 P5 V2 Q3

3 A small ball is projected from a point O on horizontal ground. At time t s after projection the horizontal and vertically upwards displacements of the ball from O are x m and y m respectively, where $x = 4t$ and $y = 6t - 5t^2$.

(i) Find the equation of the trajectory of the ball. [2]

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(ii) Hence or otherwise calculate the angle of projection of the ball and its initial speed. [4]

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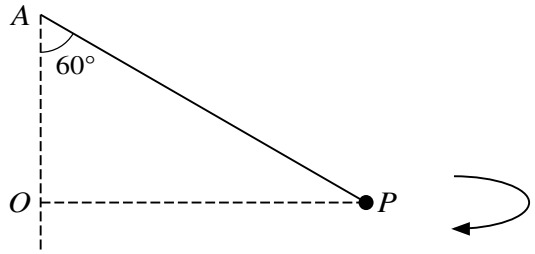
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66. Question | 9709 Feb-March 2019 P5 V2 Q4

4



A particle P of mass 0.3 kg is attached to a fixed point A by a light elastic string of natural length 0.8 m and modulus of elasticity 16 N. The particle P moves in a horizontal circle which has centre O. It is given that AO is vertical and that angle OAP is 60° (see diagram). Calculate the speed of P. [6]

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67. Question part 1/2 | 9709 Feb-March 2019 P5 V2 Q5

5 A particle P of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.6 m and modulus of elasticity 24 N. The other end of the string is attached to a fixed point O. The particle P is released from rest at the point 0.4 m vertically below O.

(i) Find the greatest speed of P. [5]

67. Question part 2/2 | 9709 Feb-March 2019 P5 V2 Q5

(ii) Calculate the greatest distance of P below O. [3]

68. Question part 1/3 | 9709 Feb-March 2019 P5 V2 Q7

7 A particle P is projected horizontally from a point O on a rough horizontal surface. The coefficient of friction between the particle and the surface is 0.2. A horizontal force of magnitude $0.06t$ N directed away from O acts on P, where t s is the time after projection. P comes to rest when $t = 4$.

(i) The particle begins to move again when $t = 8$. Show that the mass of P is 0.24 kg. [2]

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(ii) Show that, for $0 \leqslant t \leqslant 4$, $\frac{\mathrm{d}v}{\mathrm{d}t} = 0.25t - 2$, and find the speed of projection of P. [5]

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68. Question part 2/3 | 9709 Feb-March 2019 P5 V2 Q7

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(iii) Find the distance from O at which P comes to rest. [4]

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68. Question part 3/3 | 9709 Feb-March 2019 P5 V2 Q7

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69. Question | 9709 May-June 2019 P5 V1 Q2

2 A particle is projected with speed V m s^{-1} at an angle of $\theta°$ above the horizontal. At the instant 4 s after projection the speed of the particle is 16 m s^{-1} and its direction of motion is 30° above the horizontal. Find V and θ. [5]

70. Question part 1/2 | 9709 May-June 2019 P5 V1 Q4

4 A small ball is projected with speed $25\,\text{m}\,\text{s}^{-1}$ at an angle of $30°$ above the horizontal from a point O on horizontal ground. At time t s after projection the horizontal and vertically upwards displacements of the ball from O are x m and y m respectively.

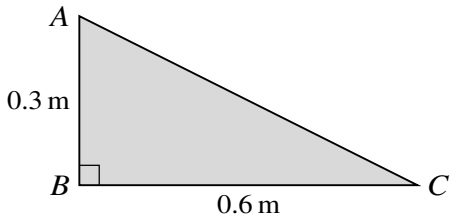
(i) Express x and y in terms of t and hence find the equation of the trajectory of the ball. [4]

70. Question part 2/2 | 9709 May-June 2019 P5 V1 Q4

(ii) Find x for the position of the ball when its path makes an angle of 15° below the horizontal. [4]

71. Question part 1/2 | 9709 May-June 2019 P5 V1 Q6

6



ABC is a uniform lamina in the form of a triangle with $AB = 0.3$ m, $BC = 0.6$ m and a right angle at B (see diagram).

(i) State the distances of the centre of mass of the lamina from AB and from BC. [2]

Distance from AB.....

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Distance from BC .....

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The lamina is freely suspended at B and hangs in equilibrium.

(ii) Find the angle between AB and the horizontal. [2]

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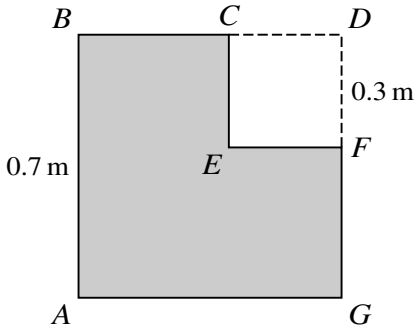
71. Question part 2/2 | 9709 May-June 2019 P5 V1 Q6

A force of magnitude 12 N is applied along the edge AC of the lamina in the direction from A towards C. The lamina, still suspended at B, is now in equilibrium with AB vertical.

(iii) Calculate the weight of the lamina. [3]

72. Question | 9709 May-June 2019 P5 V2 Q2

2



A uniform lamina $ABCEFG$ is formed from a square $ABDG$ by removing a smaller square $CDFE$ from one corner. $AB = 0.7$ m and $DF = 0.3$ m (see diagram). Find the distance of the centre of mass of the lamina from A. [4]

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73. Question part 1/2 | 9709 May-June 2019 P5 V2 Q4

4 A particle P of mass 0.5 kg is attached to one end of a light elastic string of natural length 0.8 m and modulus of elasticity 16 N. The other end of the string is attached to a fixed point O. The particle P is released from rest at the point 0.8 m vertically below O. When the extension of the string is x m, the downwards velocity of P is v m s^{-1} and a force of magnitude $25x^2$ N opposes the motion of P.

(i) Show that, when P is moving downwards, $v\frac{\mathrm{d}v}{\mathrm{d}x} = 10 - 40x - 50x^2$. [2]

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(ii) For the instant when P has its greatest downwards speed, find the kinetic energy of P and the elastic potential energy stored in the string. [6]

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73. Question part 2/2 | 9709 May-June 2019 P5 V2 Q4

74. Question part 1/2 | 9709 May-June 2019 P5 V2 Q6

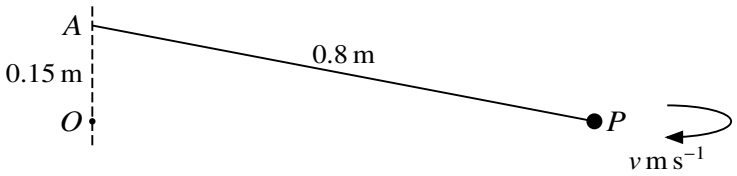
6 A particle is projected with speed $15\,\text{m}\,\text{s}^{-1}$ at an angle of $\theta°$ above the horizontal. At the instant 4 s after projection the speed of the particle is $30\,\text{m}\,\text{s}^{-1}$.

(i) Find θ. [4]

(ii) Show that at the instant 4 s after projection the particle is 33.75 m below the level of the point of projection and find the direction of motion at this instant. [4]

75. Question | 9709 May-June 2019 P5 V3 Q1

1



A particle P of mass 0.3 kg is attached to a fixed point A by a light inextensible string of length 0.8 m. The fixed point O is 0.15 m vertically below A. The particle P moves with constant speed v m s^{-1} in a horizontal circle with centre O (see diagram).

(i) Show that the tension in the string is 16 N. [2]

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(ii) Find the value of v. [3]

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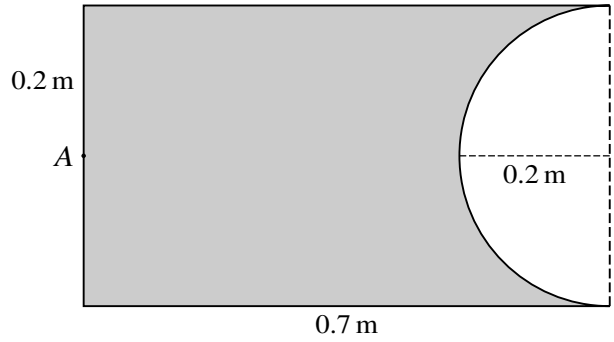
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76. Question | 9709 May-June 2019 P5 V3 Q3

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The diagram shows the cross-section through the centre of mass of a uniform solid object. The object is a cylinder of radius 0.2 m and length 0.7 m, from which a hemisphere of radius 0.2 m has been removed at one end. The point A is the centre of the plane face at the other end of the object. Find the distance of the centre of mass of the object from A. [5]

[The volume of a hemisphere is $\frac{2}{3}\pi r^3$.]

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77. Question part 1/2 | 9709 May-June 2019 P5 V3 Q5

5 A particle P of mass 0.4 kg is attached to one end of a light elastic string of natural length 0.5 m and modulus of elasticity 6 N. The other end of the string is attached to a fixed point O. The particle P is released from rest at the point $(0.5 + x)$ m vertically below O. The particle P comes to instantaneous rest at O.

(i) Find x. [3]

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(ii) Find the greatest speed of P. [5]

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77. Question part 2/2 | 9709 May-June 2019 P5 V3 Q5

78. Question part 1/3 | 9709 May-June 2019 P5 V3 Q7

7 A particle P of mass 0.5 kg is attached to a fixed point O by a light elastic string of natural length 1 m and modulus of elasticity 16 N. The particle P is projected vertically upwards from O with speed $6\,\text{m s}^{-1}$. A resisting force of magnitude $0.1x^2$ N acts on P when P has displacement x m above O. After projection the upwards velocity of P is $v\,\text{m s}^{-1}$.

(i) Show that, before the string becomes taut, $v\dfrac{\mathrm{d}v}{\mathrm{d}x} = -10 - 0.2x^2$. [2]

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(ii) Find the velocity of P at the instant the string becomes taut. [4]

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78. Question part 2/3 | 9709 May-June 2019 P5 V3 Q7

(iii) Find an expression for the acceleration of P while it is moving upwards after the string becomes taut. [2]

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(iv) Verify that P comes to instantaneous rest before the extension of the string is 0.5 m. [4]

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78. Question part 3/3 | 9709 May-June 2019 P5 V3 Q7

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79. Question | 9709 Oct-Nov 2019 P5 V1 Q2

2 A particle is projected from a point on horizontal ground with speed $15\,\text{m}\,\text{s}^{-1}$ at an angle of $\theta°$ above the horizontal. The particle strikes the ground 2 s after projection.

(i) Find θ. [2]

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(ii) Calculate the time after projection at which the direction of motion of the particle is 20° below the horizontal. [4]

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80. Question part 1/2 | 9709 Oct-Nov 2019 P5 V1 Q5

5 A particle P of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.6 m and modulus of elasticity 9 N. The other end of the string is attached to a fixed point O on a smooth plane inclined at 30° to the horizontal. OA is a line of greatest slope of the plane with A below the level of O and $OA = 0.8$ m. The particle P is released from rest at A.

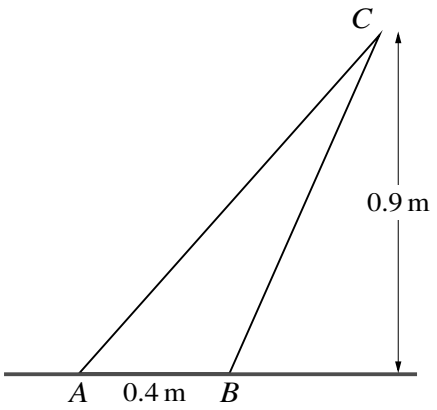
(i) Find the initial acceleration of P. [4]

80. Question part 2/2 | 9709 Oct-Nov 2019 P5 V1 Q5

(ii) Find the greatest speed of P. [5]

81. Question part 1/3 | 9709 Oct-Nov 2019 P5 V1 Q7

7



ABC is the cross-section through the centre of mass of a uniform prism which rests with AB on a rough horizontal surface. $AB = 0.4$ m and C is 0.9 m above the surface (see diagram). The prism is on the point of toppling about its edge through B.

(i) Show that angle $BAC = 48.4°$, correct to 3 significant figures. [3]

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81. Question part 2/3 | 9709 Oct-Nov 2019 P5 V1 Q7

A force of magnitude 18 N acting in the plane of the cross-section and perpendicular to AC is now applied to the prism at C. The prism is on the point of rotating about its edge through A.

(ii) Calculate the weight of the prism. [3]

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(iii) Given also that the prism is on the point of slipping, calculate the coefficient of friction between the prism and the surface. [4]

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81. Question part 3/3 | 9709 Oct-Nov 2019 P5 V1 Q7

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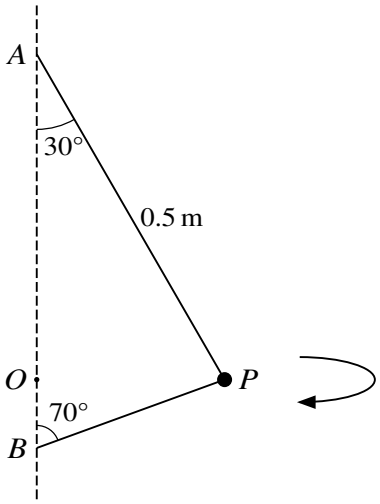
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82. Question | 9709 Oct-Nov 2019 P5 V2 Q3

3 A particle P of mass 0.5 kg is attached to one end of a light elastic string of natural length 0.6 m and modulus of elasticity 12 N. The other end of the string is attached to a fixed point O. The particle P is projected vertically downwards with speed $2\,\text{m s}^{-1}$ from the point 0.5 m vertically below O. For an instant when the acceleration of P is $4\,\text{m s}^{-2}$ downwards, find the extension of the string and the speed of P. [6]

83. Question part 1/2 | 9709 Oct-Nov 2019 P5 V2 Q5

5



A and B are two fixed points on a vertical axis with A above B. A particle P of mass 0.4 kg is attached to A by a light inextensible string of length 0.5 m. The particle P is attached to B by another light inextensible string. P moves with constant speed in a horizontal circle with centre O between A and B. Angle $BAP = 30°$ and angle $ABP = 70°$ (see diagram).

(i) Given that the tensions in the two strings are equal, find the speed of P. [5]

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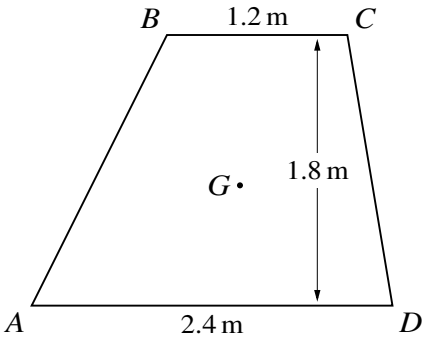
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83. Question part 2/2 | 9709 Oct-Nov 2019 P5 V2 Q5

(ii) Given instead that the angular speed of P is $12\,\text{rad}\,\text{s}^{-1}$, find the tensions in the strings. [5]

84. Question part 1/3 | 9709 Oct-Nov 2019 P5 V2 Q7

7



$ABCD$ is a uniform lamina in the shape of a trapezium which has centre of mass G. The sides AD and BC are parallel and 1.8 m apart, with $AD = 2.4$ m and $BC = 1.2$ m (see diagram).

(i) Show that the distance of G from AD is 0.8 m. [4]

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The lamina is freely suspended at A and hangs in equilibrium with AD making an angle of 30° with the vertical.

(ii) Calculate the distance AG. [2]

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With the lamina still freely suspended at A a horizontal force of magnitude 7 N acting in the plane of the lamina is applied at D. The lamina is in equilibrium with AG making an angle of 10° with the downward vertical.

(iii) Find the two possible values for the weight of the lamina. [5]

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85. Question | 9709 Oct-Nov 2019 P5 V3 Q2

2 A particle is projected from a point on horizontal ground with speed $15\,\text{m s}^{-1}$ at an angle of $\theta°$ above the horizontal. The particle strikes the ground 2 s after projection.

(i) Find θ. [2]

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(ii) Calculate the time after projection at which the direction of motion of the particle is 20° below the horizontal. [4]

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86. Question part 1/2 | 9709 Oct-Nov 2019 P5 V3 Q5

5 A particle P of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.6 m and modulus of elasticity 9 N. The other end of the string is attached to a fixed point O on a smooth plane inclined at 30° to the horizontal. OA is a line of greatest slope of the plane with A below the level of O and $OA = 0.8$ m. The particle P is released from rest at A.

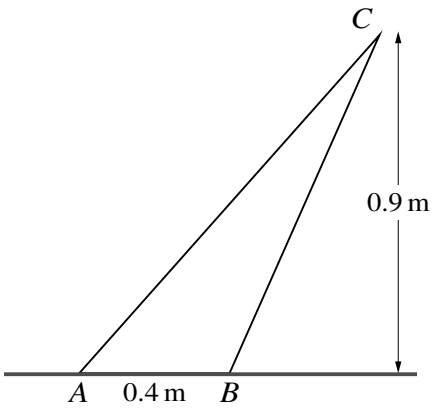
(i) Find the initial acceleration of P. [4]

86. Question part 2/2 | 9709 Oct-Nov 2019 P5 V3 Q5

(ii) Find the greatest speed of P. [5]

87. Question part 1/3 | 9709 Oct-Nov 2019 P5 V3 Q7

7



ABC is the cross-section through the centre of mass of a uniform prism which rests with AB on a rough horizontal surface. $AB = 0.4$ m and C is 0.9 m above the surface (see diagram). The prism is on the point of toppling about its edge through B.

(i) Show that angle $BAC = 48.4°$, correct to 3 significant figures. [3]

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A force of magnitude 18 N acting in the plane of the cross-section and perpendicular to AC is now applied to the prism at C. The prism is on the point of rotating about its edge through A.

(ii) Calculate the weight of the prism. [3]

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(iii) Given also that the prism is on the point of slipping, calculate the coefficient of friction between the prism and the surface. [4]

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88. Question part 1/2 | 9709 Feb-March 2020 P5 V2 Q2

2 An ordinary fair die is thrown repeatedly until a 1 or a 6 is obtained.

(a) Find the probability that it takes at least 3 throws but no more than 5 throws to obtain a 1 or a 6. [3]

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On another occasion, this die is thrown 3 times. The random variable X is the number of times that a 1 or a 6 is obtained.

(b) Draw up the probability distribution table for X. [3]

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(c) Find E(X). [2]

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89. Question part 1/2 | 9709 Feb-March 2020 P5 V2 Q5

5 In Greenton, 70% of the adults own a car. A random sample of 8 adults from Greenton is chosen.

(a) Find the probability that the number of adults in this sample who own a car is less than 6. [3]

89. Question part 2/2 | 9709 Feb-March 2020 P5 V2 Q5

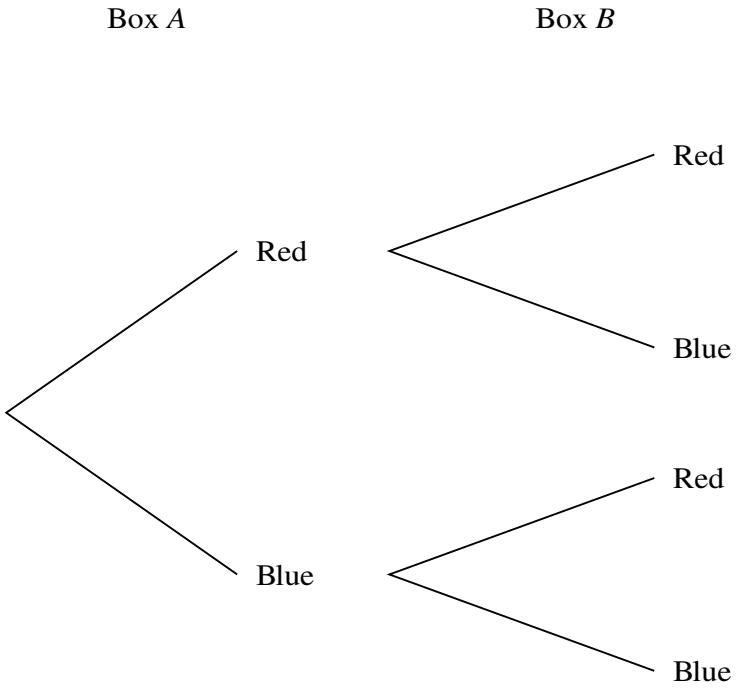
A random sample of 120 adults from Greenton is now chosen.

(b) Use an approximation to find the probability that more than 75 of them own a car. [5]

90. Question part 1/2 | 9709 Feb-March 2020 P5 V2 Q6

6 Box A contains 7 red balls and 1 blue ball. Box B contains 9 red balls and 5 blue balls. A ball is chosen at random from box A and placed in box B. A ball is then chosen at random from box B. The tree diagram below shows the possibilities for the colours of the balls chosen.

(a) Complete the tree diagram to show the probabilities. [3]



(b) Find the probability that the two balls chosen are not the same colour. [2]

(c) Find the probability that the ball chosen from box A is blue given that the ball chosen from box B is blue. [4]

91. Question | 9709 May-June 2020 P5 V1 Q1

1 The score when two fair six-sided dice are thrown is the sum of the two numbers on the upper faces.

(a) Show that the probability that the score is 4 is $\frac{1}{12}$. [1]

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The two dice are thrown repeatedly until a score of 4 is obtained. The number of throws taken is denoted by the random variable X.

(b) Find the mean of X. [1]

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(c) Find the probability that a score of 4 is first obtained on the 6th throw. [1]

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(d) Find $P(X < 8)$. [2]

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92. Question part 1/2 | 9709 May-June 2020 P5 V1 Q5

5 On Mondays, Rani cooks her evening meal. She has a pizza, a burger or a curry with probabilities 0.35, 0.44, 0.21 respectively. When she cooks a pizza, Rani has some fruit with probability 0.3. When she cooks a burger, she has some fruit with probability 0.8. When she cooks a curry, she never has any fruit.

(a) Draw a fully labelled tree diagram to represent this information. [2]

92. Question part 2/2 | 9709 May-June 2020 P5 V1 Q5

(b) Find the probability that Rani has some fruit. [2]

(c) Find the probability that Rani does not have a burger given that she does not have any fruit. [4]

93. Question | 9709 May-June 2020 P5 V2 Q2

2 A total of 500 students were asked which one of four colleges they attended and whether they preferred soccer or hockey. The numbers of students in each category are shown in the following table.

	Soccer	Hockey	Total
Amos	54	32	86
Benn	84	72	156
Canton	22	56	78
Devar	120	60	180
Total	280	220	500

(a) Find the probability that a randomly chosen student is at Canton college and prefers hockey. [1]

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(b) Find the probability that a randomly chosen student is at Devar college given that he prefers soccer. [2]

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(c) One of the students is chosen at random. Determine whether the events 'the student prefers hockey' and 'the student is at Amos college or Benn college' are independent, justifying your answer. [2]

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94. Question part 1/3 | 9709 May-June 2020 P5 V2 Q7

7 On any given day, the probability that Moena messages her friend Pasha is 0.72.

(a) Find the probability that for a random sample of 12 days Moena messages Pasha on no more than 9 days. [3]

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(b) Moena messages Pasha on 1 January. Find the probability that the next day on which she messages Pasha is 5 January. [1]

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(c) Use an approximation to find the probability that in any period of 100 days Moena messages Pasha on fewer than 64 days. [5]

94. Question part 3/3 | 9709 May-June 2020 P5 V2 Q7

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95. Question | 9709 May-June 2020 P5 V3 Q1

1 Juan goes to college each day by any one of car or bus or walking. The probability that he goes by car is 0.2, the probability that he goes by bus is 0.45 and the probability that he walks is 0.35. When Juan goes by car, the probability that he arrives early is 0.6. When he goes by bus, the probability that he arrives early is 0.1. When he walks he always arrives early.

(a) Draw a fully labelled tree diagram to represent this information. [2]

(b) Find the probability that Juan goes to college by car given that he arrives early. [4]

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96. Question | 9709 May-June 2020 P5 V3 Q2

2 In a certain large college, 22% of students own a car.

(a) 3 students from the college are chosen at random. Find the probability that all 3 students own a car. [1]

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(b) 16 students from the college are chosen at random. Find the probability that the number of these students who own a car is at least 2 and at most 4. [3]

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97. Question | 9709 Oct-Nov 2020 P5 V1 Q1

1 Two ordinary fair dice, one red and the other blue, are thrown.

Event A is 'the score on the red die is divisible by 3'.

Event B is 'the sum of the two scores is at least 9'.

(a) Find $P(A \cap B)$. [2]

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(b) Hence determine whether or not the events A and B are independent. [2]

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98. Question | 9709 Oct-Nov 2020 P5 V1 Q2

2 The probability that a student at a large music college plays in the band is 0.6. For a student who plays in the band, the probability that she also sings in the choir is 0.3. For a student who does not play in the band, the probability that she sings in the choir is x. The probability that a randomly chosen student from the college does not sing in the choir is 0.58.

(a) Find the value of x. [3]

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Two students from the college are chosen at random.

(b) Find the probability that both students play in the band and both sing in the choir. [2]

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99. Question | 9709 Oct-Nov 2020 P5 V1 Q3

3 Kayla is competing in a throwing event. A throw is counted as a success if the distance achieved is greater than 30 metres. The probability that Kayla will achieve a success on any throw is 0.25.

(a) Find the probability that Kayla takes more than 6 throws to achieve a success. [2]

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(b) Find the probability that, for a random sample of 10 throws, Kayla achieves at least 3 successes. [3]

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100. Question | 9709 Oct-Nov 2020 P5 V2 Q1

1 A fair six-sided die, with faces marked 1, 2, 3, 4, 5, 6, is thrown repeatedly until a 4 is obtained.

(a) Find the probability that obtaining a 4 requires fewer than 6 throws. [2]

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On another occasion, the die is thrown 10 times.

(b) Find the probability that a 4 is obtained at least 3 times. [3]

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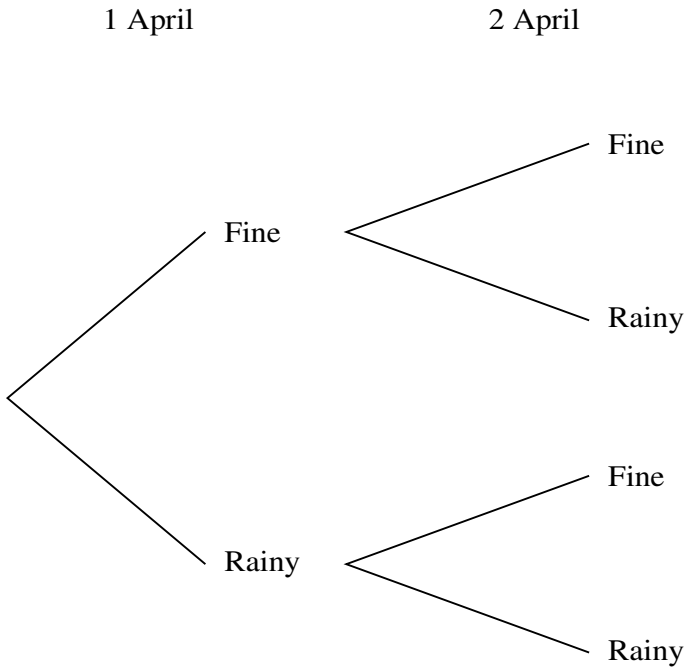
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101. Question part 1/2 | 9709 Oct-Nov 2020 P5 V2 Q4

4 In a certain country, the weather each day is classified as fine or rainy. The probability that a fine day is followed by a fine day is 0.75 and the probability that a rainy day is followed by a fine day is 0.4. The probability that it is fine on 1 April is 0.8. The tree diagram below shows the possibilities for the weather on 1 April and 2 April.

(a) Complete the tree diagram to show the probabilities. [1]



(b) Find the probability that 2 April is fine. [2]

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101. Question part 2/2 | 9709 Oct-Nov 2020 P5 V2 Q4

Let X be the event that 1 April is fine and Y be the event that 3 April is rainy.

(c) Find the value of $P(X \cap Y)$. [3]

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(d) Find the probability that 1 April is fine given that 3 April is rainy. [3]

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102. Question | 9709 Oct-Nov 2020 P5 V3 Q2

2 An ordinary fair die is thrown until a 6 is obtained.

(a) Find the probability that obtaining a 6 takes more than 8 throws. [2]

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Two ordinary fair dice are thrown together until a pair of 6s is obtained. The number of throws taken is denoted by the random variable X.

(b) Find the expected value of X. [1]

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(c) Find the probability that obtaining a pair of 6s takes either 10 or 11 throws. [2]

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103. Question | 9709 Oct-Nov 2020 P5 V3 Q4

4 The 13 00 train from Jahor to Keman runs every day. The probability that the train arrives late in Keman is 0.35.

(a) For a random sample of 7 days, find the probability that the train arrives late on fewer than 3 days. [3]

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A random sample of 142 days is taken.

(b) Use an approximation to find the probability that the train arrives late on more than 40 days. [5]

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104. Question | 9709 Feb-March 2021 P5 V2 Q1

1 A fair spinner with 5 sides numbered 1, 2, 3, 4, 5 is spun repeatedly. The score on each spin is the number on the side on which the spinner lands.

(a) Find the probability that a score of 3 is obtained for the first time on the 8th spin. [1]

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(b) Find the probability that fewer than 6 spins are required to obtain a score of 3 for the first time. [2]

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105. Question | 9709 Feb-March 2021 P5 V2 Q2

2 Georgie has a red scarf, a blue scarf and a yellow scarf. Each day she wears exactly one of these scarves. The probabilities for the three colours are 0.2, 0.45 and 0.35 respectively. When she wears a red scarf, she always wears a hat. When she wears a blue scarf, she wears a hat with probability 0.4. When she wears a yellow scarf, she wears a hat with probability 0.3.

(a) Find the probability that on a randomly chosen day Georgie wears a hat. [2]

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(b) Find the probability that on a randomly chosen day Georgie wears a yellow scarf given that she does not wear a hat. [3]

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106. Question part 1/3 | 9709 Feb-March 2021 P5 V2 Q7

7 There are 400 students at a school in a certain country. Each student was asked whether they preferred swimming, cycling or running and the results are given in the following table.

	Swimming	Cycling	Running
Female	104	50	66
Male	31	57	92

A student is chosen at random.

(a) **(i)** Find the probability that the student prefers swimming. [1]

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(ii) Determine whether the events 'the student is male' and 'the student prefers swimming' are independent, justifying your answer. [2]

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106. Question part 2/3 | 9709 Feb-March 2021 P5 V2 Q7

On average at all the schools in this country 30% of the students do not like any sports.

(b) **(i)** 10 of the students from this country are chosen at random.

Find the probability that at least 3 of these students do not like any sports. [3]

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(ii) 90 students from this country are now chosen at random.

Use an approximation to find the probability that fewer than 32 of them do not like any sports. [5]

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106. Question part 3/3 | 9709 Feb-March 2021 P5 V2 Q7

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107. Question part 1/2 | 9709 May-June 2021 P5 V1 Q4

4 To gain a place at a science college, students first have to pass a written test and then a practical test.

Each student is allowed a maximum of two attempts at the written test. A student is only allowed a second attempt if they fail the first attempt. No student is allowed more than one attempt at the practical test. If a student fails both attempts at the written test, then they cannot attempt the practical test.

The probability that a student will pass the written test at the first attempt is 0.8. If a student fails the first attempt at the written test, the probability that they will pass at the second attempt is 0.6. The probability that a student will pass the practical test is always 0.3.

(a) Draw a tree diagram to represent this information, showing the probabilities on the branches. [3]

(b) Find the probability that a randomly chosen student will succeed in gaining a place at the college. [2]

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(c) Find the probability that a randomly chosen student passes the written test at the first attempt given that the student succeeds in gaining a place at the college. [2]

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108. Question part 1/2 | 9709 May-June 2021 P5 V1 Q6

6 In Questa, 60% of the adults travel to work by car.

(a) A random sample of 12 adults from Questa is taken.

Find the probability that the number who travel to work by car is less than 10. [3]

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(b) A random sample of 150 adults from Questa is taken.

Use an approximation to find the probability that the number who travel to work by car is less than 81. [5]

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108. Question part 2/2 | 9709 May-June 2021 P5 V1 Q6

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(c) Justify the use of your approximation in part **(b)**. [1]

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109. Question part 1/3 | 9709 May-June 2021 P5 V1 Q7

7 Sharma knows that she has 3 tins of carrots, 2 tins of peas and 2 tins of sweetcorn in her cupboard. All the tins are the same shape and size, but the labels have all been removed, so Sharma does not know what each tin contains.

Sharma wants carrots for her meal, and she starts opening the tins one at a time, chosen randomly, until she opens a tin of carrots. The random variable X is the number of tins that she needs to open.

(a) Show that $P(X = 3) = \frac{6}{35}$. [2]

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(b) Draw up the probability distribution table for X. [4]

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109. Question part 2/3 | 9709 May-June 2021 P5 V1 Q7

(c) Find $\mathrm{Var}(X)$. [3]

109. Question part 3/3 | 9709 May-June 2021 P5 V1 Q7

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110. Question | 9709 May-June 2021 P5 V2 Q3

3 On each day that Alexa goes to work, the probabilities that she travels by bus, by train or by car are 0.4, 0.35 and 0.25 respectively. When she travels by bus, the probability that she arrives late is 0.55. When she travels by train, the probability that she arrives late is 0.7. When she travels by car, the probability that she arrives late is x.

On a randomly chosen day when Alexa goes to work, the probability that she does not arrive late is 0.48.

(a) Find the value of x. [3]

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(b) Find the probability that Alexa travels to work by train given that she arrives late. [3]

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111. Question part 1/2 | 9709 May-June 2021 P5 V3 Q4

4 Three fair six-sided dice, each with faces marked 1, 2, 3, 4, 5, 6, are thrown at the same time, repeatedly. For a single throw of the three dice, the score is the sum of the numbers on the top faces.

(a) Find the probability that the score is 4 on a single throw of the three dice. [3]

111. Question part 2/2 | 9709 May-June 2021 P5 V3 Q4

(b) Find the probability that a score of 18 is obtained for the first time on the 5th throw of the three dice. [3]

112. Question part 1/3 | 9709 May-June 2021 P5 V3 Q7

7 In the region of Arka, the total number of households in the three villages Reeta, Shan and Teber is 800. Each of the households was asked about the quality of their broadband service. Their responses are summarised in the following table.

		Quality of broadband service		
		Excellent	Good	Poor
Village	Reeta	75	118	32
	Shan	223	177	40
	Teber	12	60	63

(a) **(i)** Find the probability that a randomly chosen household is in Shan and has poor broadband service. [1]

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(ii) Find the probability that a randomly chosen household has good broadband service given that the household is in Shan. [2]

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In the whole of Arka there are a large number of households. A survey showed that 35% of households in Arka have no broadband service.

(b) **(i)** 10 households in Arka are chosen at random.

Find the probability that fewer than 3 of these households have no broadband service. [3]

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112. Question part 2/3 | 9709 May-June 2021 P5 V3 Q7

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(ii) 120 households in Arka are chosen at random.

Use an approximation to find the probability that more than 32 of these households have no broadband service. [5]

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112. Question part 3/3 | 9709 May-June 2021 P5 V3 Q7

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113. Question | 9709 Oct-Nov 2021 P5 V1 Q3

3 For her bedtime drink, Suki has either chocolate, tea or milk with probabilities 0.45, 0.35 and 0.2 respectively. When she has chocolate, the probability that she has a biscuit is 0.3. When she has tea, the probability that she has a biscuit is 0.6. When she has milk, she never has a biscuit.

Find the probability that Suki has tea given that she does not have a biscuit. [5]

114. Question | 9709 Oct-Nov 2021 P5 V2 Q1

1 Each of the 180 students at a college plays exactly one of the piano, the guitar and the drums. The numbers of male and female students who play the piano, the guitar and the drums are given in the following table.

	Piano	Guitar	Drums
Male	25	44	11
Female	42	38	20

A student at the college is chosen at random.

(a) Find the probability that the student plays the guitar. [1]

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(b) Find the probability that the student is male given that the student plays the drums. [2]

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(c) Determine whether the events 'the student plays the guitar' and 'the student is female' are independent, justifying your answer. [2]

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115. Question part 1/2 | 9709 Oct-Nov 2021 P5 V2 Q3

3 A bag contains 5 yellow and 4 green marbles. Three marbles are selected at random from the bag, without replacement.

(a) Show that the probability that exactly one of the marbles is yellow is $\frac{5}{14}$. [3]

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The random variable X is the number of yellow marbles selected.

(b) Draw up the probability distribution table for X. [3]

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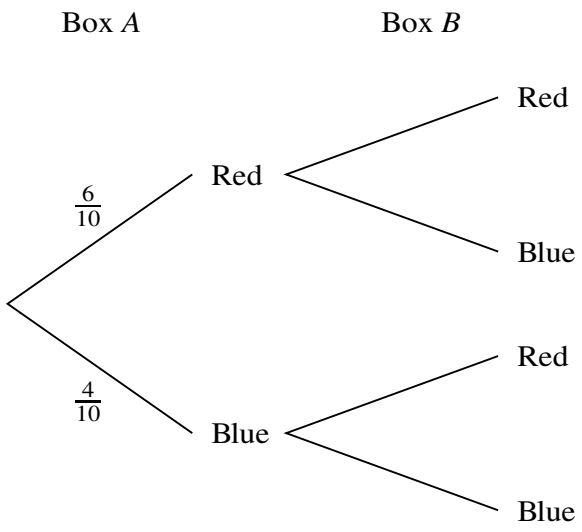
115. Question part 2/2 | 9709 Oct-Nov 2021 P5 V2 Q3

(c) Find $\mathrm{E}(X)$. [1]

116. Question part 1/3 | 9709 Oct-Nov 2021 P5 V3 Q7

7 Box A contains 6 red balls and 4 blue balls. Box B contains x red balls and 9 blue balls. A ball is chosen at random from box A and placed in box B. A ball is then chosen at random from box B.

(a) Complete the tree diagram below, giving the remaining four probabilities in terms of x. [3]



(b) Show that the probability that both balls chosen are blue is $\frac{4}{x+10}$. [2]

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116. Question part 2/3 | 9709 Oct-Nov 2021 P5 V3 Q7

It is given that the probability that both balls chosen are blue is $\frac{1}{6}$.

(c) Find the probability, correct to 3 significant figures, that the ball chosen from box A is red given that the ball chosen from box B is red. [5]

116. Question part 3/3 | 9709 Oct-Nov 2021 P5 V3 Q7

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117. Question | 9709 Feb-March 2022 P5 V2 Q2

2 In a certain country, the probability of more than 10 cm of rain on any particular day is 0.18, independently of the weather on any other day.

(a) Find the probability that in any randomly chosen 7-day period, more than 2 days have more than 10 cm of rain. [3]

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(b) For 3 randomly chosen 7-day periods, find the probability that exactly two of these periods have at least one day with more than 10 cm of rain. [3]

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118. Question part 1/3 | 9709 Feb-March 2022 P5 V2 Q6

6 A factory produces chocolates in three flavours: lemon, orange and strawberry in the ratio 3 : 5 : 7 respectively. Nell checks the chocolates on the production line by choosing chocolates randomly one at a time.

(a) Find the probability that the first chocolate with lemon flavour that Nell chooses is the 7th chocolate that she checks. [1]

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(b) Find the probability that the first chocolate with lemon flavour that Nell chooses is after she has checked at least 6 chocolates. [2]

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'Surprise' boxes of chocolates each contain 15 chocolates: 3 are lemon, 5 are orange and 7 are strawberry.

Petra has a box of Surprise chocolates. She chooses 3 chocolates at random from the box. She eats each chocolate before choosing the next one.

(c) Find the probability that none of Petra's 3 chocolates has orange flavour. [2]

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(d) Find the probability that each of Petra's 3 chocolates has a different flavour. [3]

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(e) Find the probability that at least 2 of Petra's 3 chocolates have strawberry flavour given that none of them has orange flavour. [4]

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118. Question part 3/3 | 9709 Feb-March 2022 P5 V2 Q6

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119. Question part 1/3 | 9709 May-June 2022 P5 V1 Q6

6 Janice is playing a computer game. She has to complete level 1 and level 2 to finish the game. She is allowed at most two attempts at any level.

- For level 1, the probability that Janice completes it at the first attempt is 0.6. If she fails at her first attempt, the probability that she completes it at the second attempt is 0.3.
- If Janice completes level 1, she immediately moves on to level 2.
- For level 2, the probability that Janice completes it at the first attempt is 0.4. If she fails at her first attempt, the probability that she completes it at the second attempt is 0.2.

(a) Show that the probability that Janice moves on to level 2 is 0.72. [1]

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(b) Find the probability that Janice finishes the game. [3]

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119. Question part 2/3 | 9709 May-June 2022 P5 V1 Q6

(c) Find the probability that Janice fails exactly one attempt, given that she finishes the game. [4]

119. Question part 3/3 | 9709 May-June 2022 P5 V1 Q6

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120. Question part 1/2 | 9709 May-June 2022 P5 V2 Q5

5 In a large college, 28% of the students do not play any musical instrument, 52% play exactly one musical instrument and the remainder play two or more musical instruments.

A random sample of 12 students from the college is chosen.

(a) Find the probability that more than 9 of these students play at least one musical instrument. [3]

120. Question part 2/2 | 9709 May-June 2022 P5 V2 Q5

A random sample of 90 students from the college is now chosen.

(b) Use an approximation to find the probability that fewer than 40 of these students play exactly one musical instrument. [5]

121. Question part 1/3 | 9709 May-June 2022 P5 V2 Q7

7 Hanna buys 12 hollow chocolate eggs that each contain a sweet. The eggs look identical but Hanna knows that 3 contain a red sweet, 4 contain an orange sweet and 5 contain a yellow sweet. Each of Hanna's three children in turn randomly chooses and eats one of the eggs, keeping the sweet it contained.

(a) Find the probability that all 3 eggs chosen contain the same colour sweet. [4]

121. Question part 2/3 | 9709 May-June 2022 P5 V2 Q7

(b) Find the probability that all 3 eggs chosen contain a yellow sweet, given that all three children have the same colour sweet. [2]

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(c) Find the probability that at least one of Hanna's three children chooses an egg that contains an orange sweet. [3]

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121. Question part 3/3 | 9709 May-June 2022 P5 V2 Q7

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122. Question | 9709 May-June 2022 P5 V3 Q4

4 Ramesh throws an ordinary fair 6-sided die.

(a) Find the probability that he obtains a 4 for the first time on his 8th throw. [1]

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(b) Find the probability that it takes no more than 5 throws for Ramesh to obtain a 4. [2]

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Ramesh now repeatedly throws two ordinary fair 6-sided dice at the same time. Each time he adds the two numbers that he obtains.

(c) For 10 randomly chosen throws of the two dice, find the probability that Ramesh obtains a total of less than 4 on at least three throws. [4]

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123. Question part 1/2 | 9709 May-June 2022 P5 V3 Q6

6 Sajid is practising for a long jump competition. He counts any jump that is longer than 6 m as a success. On any day, the probability that he has a success with his first jump is 0.2. For any subsequent jump, the probability of a success is 0.3 if the previous jump was a success and 0.1 otherwise. Sajid makes three jumps.

(a) Draw a tree diagram to illustrate this information, showing all the probabilities. [2]

(b) Find the probability that Sajid has exactly one success given that he has at least one success. [5]

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On another day, Sajid makes six jumps.

(c) Find the probability that only his first three jumps are successes or only his last three jumps are successes. [3]

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124. Question | 9709 Oct-Nov 2022 P5 V1 Q2

2 The residents of Persham were surveyed about the reliability of their internet service. 12% rated the service as 'poor', 36% rated it as 'satisfactory' and 52% rated it as 'good'.

A random sample of 8 residents of Persham is chosen.

(a) Find the probability that more than 2 and fewer than 8 of them rate their internet service as poor or satisfactory. [3]

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A random sample of 125 residents of Persham is now chosen.

(b) Use an approximation to find the probability that more than 72 of these residents rate their internet service as good. [5]

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125. Question part 1/2 | 9709 Oct-Nov 2022 P5 V1 Q5

5 A game is played with an ordinary fair 6-sided die. A player throws the die once. If the result is 2, 3, 4 or 5, that result is the player's score and the player does not throw the die again. If the result is 1 or 6, the player throws the die a second time and the player's score is the sum of the two numbers from the two throws.

(a) Draw a fully labelled tree diagram to represent this information. [2]

Events A and B are defined as follows.

A: the player's score is 5, 6, 7, 8 or 9

B: the player has two throws

(b) Show that $\mathrm{P}(A) = \frac{1}{3}$. [3]

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125. Question part 2/2 | 9709 Oct-Nov 2022 P5 V1 Q5

(c) Determine whether or not events A and B are independent. [2]

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(d) Find $\mathrm{P}(B \mid A')$. [3]

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126. Question | 9709 Oct-Nov 2022 P5 V2 Q1

1 On any day, Kino travels to school by bus, by car or on foot with probabilities 0.2, 0.1 and 0.7 respectively. The probability that he is late when he travels by bus is x. The probability that he is late when he travels by car is $2x$ and the probability that he is late when he travels on foot is 0.25.

The probability that, on a randomly chosen day, Kino is late is 0.235.

(a) Find the value of x. [3]

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(b) Find the probability that, on a randomly chosen day, Kino travels to school by car given that he is not late. [2]

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127. Question | 9709 Oct-Nov 2022 P5 V2 Q3

3 Three fair 6-sided dice, each with faces marked 1, 2, 3, 4, 5, 6, are thrown at the same time repeatedly. The score on each throw is the sum of the numbers on the uppermost faces.

(a) Find the probability that a score of 17 or more is first obtained on the 6th throw. [3]

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(b) Find the probability that a score of 17 or more is obtained in fewer than 8 throws. [2]

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128. Question part 1/2 | 9709 Oct-Nov 2022 P5 V2 Q6

6 At a company's call centre, 90% of callers are connected immediately to a representative.

A random sample of 12 callers is chosen.

(a) Find the probability that fewer than 10 of these callers are connected immediately. [3]

128. Question part 2/2 | 9709 Oct-Nov 2022 P5 V2 Q6

A random sample of 80 callers is chosen.

(b) Use an approximation to find the probability that more than 69 of these callers are connected immediately. [5]

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(c) Justify the use of your approximation in part **(b)**. [1]

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129. Question part 1/3 | 9709 Oct-Nov 2022 P5 V3 Q7

7 Sam and Tom are playing a game which involves a bag containing 5 white discs and 3 red discs. They take turns to remove one disc from the bag at random. Discs that are removed are not replaced into the bag. The game ends as soon as one player has removed two red discs from the bag. That player wins the game.

Sam removes the first disc.

(a) Find the probability that Tom removes a red disc on his first turn. [2]

129. Question part 2/3 | 9709 Oct-Nov 2022 P5 V3 Q7

(b) Find the probability that Tom wins the game on his second turn. [4]

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(c) Find the probability that Sam removes a red disc on his first turn given that Tom wins the game on his second turn. [2]

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129. Question part 3/3 | 9709 Oct-Nov 2022 P5 V3 Q7

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130. Question part 1/2 | 9709 Feb-March 2023 P5 V2 Q2

2 Alisha has four coins. One of these coins is biased so that the probability of obtaining a head is 0.6. The other three coins are fair. Alisha throws the four coins at the same time. The random variable X denotes the number of heads obtained.

(a) Show that the probability of obtaining exactly one head is 0.225. [3]

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(b) Complete the following probability distribution table for X. [2]

x	0	1	2	3	4
$P(X = x)$	0.05	0.225			0.075

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(c) Given that $\mathrm{E}(X) = 2.1$, find the value of $\mathrm{Var}(X)$. [2]

131. Question | 9709 Feb-March 2023 P5 V2 Q4

4 The probability that it will rain on any given day is x. If it is raining, the probability that Aran wears a hat is 0.8 and if it is not raining, the probability that he wears a hat is 0.3. Whether it is raining or not, if Aran wears a hat, the probability that he wears a scarf is 0.4. If he does not wear a hat, the probability that he wears a scarf is 0.1. The probability that on a randomly chosen day it is not raining and Aran is not wearing a hat or a scarf is 0.36.

Find the value of x. [3]

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132. Question | 9709 Feb-March 2023 P5 V2 Q5

5 Marco has four boxes labelled K, L, M and N. He places them in a straight line in the order K, L, M, N with K on the left. Marco also has four coloured marbles: one is red, one is green, one is white and one is yellow. He places a single marble in each box, at random. Events A and B are defined as follows.

A: The white marble is in either box L or box M.

B: The red marble is to the left of both the green marble and the yellow marble.

Determine whether or not events A and B are independent. [3]

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133. Question part 1/3 | 9709 May-June 2023 P5 V1 Q7

7 A children's wildlife magazine is published every Monday. For the next 12 weeks it will include a model animal as a free gift. There are five different models: tiger, leopard, rhinoceros, elephant and buffalo, each with the same probability of being included in the magazine.

Sahim buys one copy of the magazine every Monday.

(a) Find the probability that the first time that the free gift is an elephant is before the 6th Monday. [2]

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(b) Find the probability that Sahim will get more than two leopards in the 12 magazines. [3]

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133. Question part 2/3 | 9709 May-June 2023 P5 V1 Q7

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(c) Find the probability that after 5 weeks Sahim has exactly one of each animal. [3]

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133. Question part 3/3 | 9709 May-June 2023 P5 V1 Q7

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134. Question part 1/2 | 9709 May-June 2023 P5 V2 Q2

2 A sports event is taking place for 4 days, beginning on Sunday. The probability that it will rain on Sunday is 0.4. On any subsequent day, the probability that it will rain is 0.7 if it rained on the previous day and 0.2 if it did not rain on the previous day.

(a) Find the probability that it does **not** rain on any of the 4 days of the event. [1]

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(b) Find the probability that the first day on which it rains during the event is Tuesday. [2]

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134. Question part 2/2 | 9709 May-June 2023 P5 V2 Q2

(c) Find the probability that it rains on exactly one of the 4 days of the event. [3]

135. Question part 1/2 | 9709 May-June 2023 P5 V2 Q4

4 A fair 5-sided spinner has sides labelled 1, 2, 3, 4, 5. The spinner is spun repeatedly until a 2 is obtained on the side on which the spinner lands. The random variable X denotes the number of spins required.

(a) Find $P(X = 4)$. [1]

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(b) Find $P(X < 6)$. [2]

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Two fair 5-sided spinners, each with sides labelled 1, 2, 3, 4, 5, are spun at the same time. If the numbers obtained are equal, the score is 0. Otherwise, the score is the higher number minus the lower number.

(c) Find the probability that the score is greater than 0 given that the score is **not** equal to 2. [3]

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The two spinners are spun at the same time repeatedly .

(d) For 9 randomly chosen spins of the two spinners, find the probability that the score is greater than 2 on at least 3 occasions. [3]

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136. Question | 9709 May-June 2023 P5 V3 Q5

5 Jasmine throws two ordinary fair 6-sided dice at the same time and notes the numbers on the uppermost faces. The events A and B are defined as follows.

A: The sum of the two numbers is less than 6.

B: The difference between the two numbers is at most 2.

(a) Determine whether or not the events A and B are independent. [4]

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(b) Find $\mathrm{P}(B \mid A')$. [3]

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137. Question part 1/2 | 9709 Oct-Nov 2023 P5 V1 Q5

5 A red spinner has four sides labelled 1, 2, 3, 4. When the spinner is spun, the score is the number on the side on which it lands. The random variable X denotes this score. The probability distribution table for X is given below.

x	1	2	3	4
$P(X = x)$	0.28	p	$2p$	$3p$

(a) Show that $p = 0.12$. [1]

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A fair blue spinner and a fair green spinner each have four sides labelled 1, 2, 3, 4. All three spinners (red, blue and green) are spun at the same time.

(b) Find the probability that the sum of the three scores is 4 or less. [3]

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137. Question part 2/2 | 9709 Oct-Nov 2023 P5 V1 Q5

(c) Find the probability that the product of the three scores is 4 or less given that X is odd. [5]

138. Question | 9709 Oct-Nov 2023 P5 V2 Q2

2 George has a fair 5-sided spinner with sides labelled 1, 2, 3, 4, 5. He spins the spinner and notes the number on the side on which the spinner lands.

(a) Find the probability that it takes fewer than 7 spins for George to obtain a 5. [2]

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George spins the spinner 10 times.

(b) Find the probability that he obtains a 5 more than 4 times but fewer than 8 times. [3]

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139. Question part 1/2 | 9709 Oct-Nov 2023 P5 V2 Q6

6 Freddie has two bags of marbles.

Bag X contains 7 red marbles and 3 blue marbles.

Bag Y contains 4 red marbles and 1 blue marble.

Freddie chooses one of the bags at random. A marble is removed at random from that bag and not replaced. A new red marble is now added to each bag. A second marble is then removed at random from the same bag that the first marble had been removed from.

(a) Draw a tree diagram to represent this information, showing the probability on each of the branches. [3]

(b) Find the probability that both of the marbles removed from the bag are the same colour. [4]

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(c) Find the probability that bag Y is chosen given that the marbles removed are **not** both the same colour. [2]

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140. Question part 1/2 | 9709 Oct-Nov 2023 P5 V3 Q3

3 Tim has two bags of marbles, A and B.

Bag A contains 8 white, 4 red and 3 yellow marbles.

Bag B contains 6 white, 7 red and 2 yellow marbles.

Tim also has an ordinary fair 6-sided dice. He rolls the dice. If he obtains a 1 or 2, he chooses two marbles at random from bag A, without replacement. If he obtains a 3, 4, 5 or 6, he chooses two marbles at random from bag B, without replacement.

(a) Find the probability that both marbles are white. [3]

(b) Find the probability that the two marbles come from bag B given that one is white and one is red. [4]

141. Question | 9709 Feb-March 2024 P5 V2 Q1

1 A bag contains 9 blue marbles and 3 red marbles. One marble is chosen at random from the bag. If this marble is blue, it is replaced back into the bag. If this marble is red, it is **not** returned to the bag. A second marble is now chosen at random from the bag.

(a) Find the probability that both the marbles chosen are red. [1]

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(b) Find the probability that the first marble chosen is blue given that the second marble chosen is red. [3]

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142. Question part 1/2 | 9709 Feb-March 2024 P5 V2 Q2

2 Sam is a member of a soccer club. She is practising scoring goals. The probability that Sam will score a goal on any attempt is 0.7, independently of all other attempts.

(a) Sam makes 10 attempts at scoring goals.

Find the probability that Sam will score goals on fewer than 8 of these attempts. [3]

(b) Find the probability that Sam's first successful attempt will be before her 5th attempt. [2]

142. Question part 2/2 | 9709 Feb-March 2024 P5 V2 Q2

(c) Wei is a member of the same soccer club. He is also practising scoring goals. The probability that Wei will score a goal on any attempt is 0.6, independently of all other attempts.

Wei is going to keep making attempts until he scores 3 goals.

Find the probability that he scores his third goal on his 7th attempt. [3]

143. Question part 1/2 | 9709 May-June 2024 P5 V1 Q4

4 A game for two players is played using a fair 4-sided dice with sides numbered 1, 2, 3 and 4. One turn consists of throwing the dice repeatedly up to a maximum of three times. When a 4 is obtained, no further throws are made during that turn. A player who obtains a 4 in their turn scores 1 point.

(a) Show that the probability that a player obtains a 4 in one turn is $\frac{37}{64}$. [2]

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Xeno and Yao play this game.

(b) Find the probability that neither Xeno nor Yao score any points in their first two turns. [1]

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143. Question part 2/2 | 9709 May-June 2024 P5 V1 Q4

(c) Xeno and Yao each have three turns.

Find the probability that Xeno scores 2 more points than Yao. [3]

144. Question part 1/2 | 9709 May-June 2024 P5 V1 Q5

5 In a certain area in the Arctic the probability that it snows on any given day is 0.7, independent of all other days.

(a) Find the probability that in a week (7 days) it snows on at least five days. [3]

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A week in which it snows on at least five days out of seven is called a 'white' week.

(b) Find the probability that in three randomly chosen weeks at least one is a white week. [2]

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144. Question part 2/2 | 9709 May-June 2024 P5 V1 Q5

In a different area in the Arctic, the probability that a week is a white week is 0.8 .

(c) Use a suitable approximation to find the probability that in 60 randomly chosen weeks fewer than 47 are white weeks. [5]

145. Question | 9709 May-June 2024 P5 V2 Q1

1 Rajesh applies once every year for a ticket to a music festival. The probability that he is successful in any particular year is 0.3, independently of other years.

(a) Find the probability that Rajesh is successful for the first time on his 7th attempt. [1]

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(b) Find the probability that Rajesh is successful for the first time before his 6th attempt. [2]

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(c) Find the probability that Rajesh is successful for the second time on his 10th attempt. [2]

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146. Question | 9709 May-June 2024 P5 V2 Q2

2 Seva has a coin which is biased so that when it is thrown the probability of obtaining a head is $\frac{1}{3}$. He also has a bag containing 4 red marbles and 5 blue marbles.

Seva throws the coin. If he obtains a head, he selects one marble from the bag at random. If he obtains a tail, he selects two marbles from the bag at random and without replacement.

(a) Find the probability that Seva selects at least one red marble. [3]

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(b) Find the probability that Seva obtains a head given that he selects no red marbles. [2]

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147. Question part 1/2 | 9709 May-June 2024 P5 V3 Q3

3 Box A contains 6 green balls and 3 yellow balls.

Box B contains 4 green balls and x yellow balls.

A ball is chosen at random from box A and placed in box B. A ball is then chosen at random from box B.

(a) Draw a tree diagram to represent this information, showing the probability on each of the branches. [4]

147. Question part 2/2 | 9709 May-June 2024 P5 V3 Q3

The probability that both the balls chosen are the same colour is $\frac{8}{15}$.

(b) Find the value of x. [3]

148. Question part 1/2 | 9709 May-June 2024 P5 V3 Q5

5 Salah decides to attempt the crossword puzzle in his newspaper each day. The probability that he will complete the puzzle on any given day is 0.65, independent of other days.

(a) Find the probability that Salah completes the puzzle for the first time on the 5th day. [1]

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(b) Find the probability that Salah completes the puzzle for the second time on the 5th day. [2]

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(c) Find the probability that Salah completes the puzzle fewer than 5 times in a week (7 days). [3]

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(d) Use a suitable approximation to find the probability that Salah completes the puzzle more than 50 times in a period of 84 days. [5]

149. Question part 1/2 | 9709 Oct-Nov 2024 P5 V1 Q4

4 Rahul has two bags, X and Y. Bag X contains 4 red marbles and 2 blue marbles. Bag Y contains 3 red marbles and 4 blue marbles. Rahul also has a coin which is biased so that the probability of obtaining a head when it is thrown is $\frac{1}{4}$.

Rahul throws the coin.

- If he obtains a head, he chooses at random a marble from bag X. He notes the colour and replaces the marble in bag X. He then chooses at random a second marble from bag X.
- If he obtains a tail, he chooses at random a marble from bag Y. He notes the colour and discards the marble. He then chooses at random a second marble from bag Y.

(a) Find the probability that the two marbles that Rahul chooses are the same colour. [3]

149. Question part 2/2 | 9709 Oct-Nov 2024 P5 V1 Q4

(b) Find the probability that the two marbles that Rahul chooses are both from bag Y given that both marbles are blue. [3]

150. Question | 9709 Oct-Nov 2024 P5 V2 Q1

1 At a college, the students choose exactly one of tennis, hockey or netball to play. The table shows the numbers of students in Year 1 and Year 2 at the college playing each of these sports.

	Tennis	Hockey	Netball
Year 1	16	22	12
Year 2	24	18	28

One student is chosen at random from the 120 students. Events X and N are defined as follows:

X: the student is in Year 1

N: the student plays netball.

(a) Find $\mathrm{P}(X \mid N)$. [1]

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(b) Find $\mathrm{P}(N \mid X)$. [1]

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(c) Determine whether or not X and N are independent events. [1]

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One of the students who plays netball takes 8 shots at goal. On each shot, the probability that she will succeed is 0.15, independently of all other shots.

(d) Find the probability that she succeeds on fewer than 3 of these shots. [3]

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151. Question part 1/3 | 9709 Oct-Nov 2024 P5 V2 Q7

7 In a game, players attempt to score a goal by kicking a ball into a net. The probability that Leno scores a goal is 0.4 on any attempt, independently of all other attempts. The random variable X denotes the number of attempts that it takes Leno to score a goal.

(a) Find $\mathrm{P}(X = 5)$. [1]

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(b) Find $\mathrm{P}(3 \leqslant X \leqslant 7)$. [2]

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(c) Find the probability that Leno scores his second goal on or before his 5th attempt. [3]

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151. Question part 2/3 | 9709 Oct-Nov 2024 P5 V2 Q7

Leno has 75 attempts to score a goal.

(d) Use a suitable approximation to find the probability that Leno scores more than 28 goals but fewer than 35 goals. [5]

151. Question part 3/3 | 9709 Oct-Nov 2024 P5 V2 Q7

Additional page

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

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152. Question part 1/2 | 9709 Oct-Nov 2024 P5 V3 Q5

5 A factory produces chocolates. 30% of the chocolates are wrapped in gold foil, 25% are wrapped in red foil and the remainder are unwrapped.

Indigo chooses 8 chocolates at random from the production line.

(a) Find the probability that she obtains no more than 2 chocolates that are wrapped in red foil. [3]

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Jake chooses chocolates one at a time at random from the production line.

(b) Find the probability that the first time he obtains a chocolate that is wrapped in red foil is before the 7th choice. [2]

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152. Question part 2/2 | 9709 Oct-Nov 2024 P5 V3 Q5

Keifa chooses chocolates one at a time at random from the production line.

(c) Find the probability that the second chocolate chosen is the first one wrapped in gold foil given that the fifth chocolate chosen is the first unwrapped chocolate. [5]

153. Question part 1/2 | 9709 Feb-March 2025 P5 V2 Q2

2 Last year, an online store sold a large number of computers. 55% of the computers were made by company *F*, 30% were made by company *G* and 15% were made by company *H*.

A random sample of 3 customers who each bought a computer from this store is chosen.

(a) Find the probability that the 3 customers bought computers all made by different companies. [1]

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A random sample of 12 customers who each bought a computer from this store is chosen.

(b) Find the probability that fewer than 10 of these customers bought a computer made by company *F*. [3]

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153. Question part 2/2 | 9709 Feb-March 2025 P5 V2 Q2

A random sample of 140 customers who each bought a computer from this store is chosen.

(c) Use a suitable approximation to find the probability that more than 24 of these customers bought a computer made by company *H*. [5]

154. Question part 1/2 | 9709 Feb-March 2025 P5 V2 Q4

4 Eddie has 16 toy cars, of which 8 are white, 5 are black and 3 are silver. He places all the cars in a bag and selects three of them at random, without replacement.

(a) Find the probability that all three cars are the same colour. [3]

154. Question part 2/2 | 9709 Feb-March 2025 P5 V2 Q4

(b) Find the probability that, when the 3 cars are selected, at least one car is white and at least one car is black. [4]

155. Question | 9709 May-June 2025 P5 V1 Q2

2 **(a)** Find the number of different arrangements of the 8 letters in the word KANGAROO in which the two As are together and the two Os are **not** together. [3]

A fair 8-sided dice has faces labelled K, A, N, G, A, R, O, O. The dice is rolled repeatedly.

(b) Find the probability that fewer than 6 rolls of this dice are required to obtain an A. [2]

(c) Find the probability that the second A is obtained on the 6th roll of the dice. [2]

156. Question | 9709 May-June 2025 P5 V2 Q3

3 A bag contains 4 blue marbles and 12 red marbles. One marble is selected at random from the bag. If this marble is blue, it is replaced in the bag, but if it is red, it is not replaced. A second marble is now selected at random from the bag.

(a) Find the probability that both marbles selected are the same colour. [2]

(b) Find the probability that the first marble is blue given that the second marble is red. [3]

157. Question | 9709 May-June 2025 P5 V2 Q4

4 Vehicles approaching a certain road junction from Bromley must go either left, right or straight on. Over time, it is known that 30% turn left, 25% turn right and 45% go straight on. The driver of each vehicle chooses a direction independently of all other drivers.

(a) Find the probability that the next three vehicles approaching this junction from Bromley all go in different directions. [2]

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(b) Find the probability that, from the vehicles approaching this junction from Bromley today, the 1st vehicle to go left is before the 9th vehicle. [2]

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(c) Find the probability that, from the vehicles approaching this junction from Bromley today, the 2nd vehicle to go left is the 7th vehicle. [2]

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158. Question | 9709 May-June 2025 P5 V3 Q2

2 At a large college, all students who study Science also study exactly one of Art or Drama or Music. 20% of these students study Art, 45% study Drama and 35% study Music.

(a) 3 students are selected at random from the students who study Science.

Find the probability that at least 1 of these students studies Drama. [2]

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(b) 10 students are selected at random from the students who study Science.

Find the probability that more than 7 study Art or Music. [3]

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159. Question | 9709 May-June 2025 P5 V3 Q3

3 A fair six-sided dice with faces labelled 1, 2, 3, 4, 5, 6 is thrown repeatedly until a 3 is obtained. The number of throws taken is denoted by the random variable X.

(a) Find $P(X = 8)$. [1]

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(b) Find $P(X < 9)$. [2]

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(c) Find the probability that a 3 is obtained for the second time before the 6th throw. [3]

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160. Question part 1/2 | 9709 May-June 2025 P5 V3 Q5

5 Bag A contains 6 red marbles, 5 blue marbles and 1 green marble.

Bag B contains 5 red marbles and 3 blue marbles.

A marble is chosen at random from bag A and placed in bag B.

A marble is now chosen at random from bag B.

(a) Draw a tree diagram to represent this information, giving the probability on each branch. [3]

160. Question part 2/2 | 9709 May-June 2025 P5 V3 Q5

(b) Find the probability that both marbles chosen are the same colour. [2]

(c) Find the probability that the marble chosen from bag *A* is blue, given that the marble chosen from bag *B* is blue. [3]

161. Question | 9709 May-June 2025 P5 V5 Q3

3 In a certain large school, on average, two pupils in five have music lessons.

A random sample of 80 pupils from this school is chosen.

(a) Use an approximation to find the probability that fewer than 27 pupils have music lessons. [5]

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A random sample of 10 pupils from this school is now chosen.

(b) Find the probability that no more than 2 pupils have music lessons. [3]

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162. Question part 1/2 | 9709 May-June 2025 P5 V5 Q4

4 Students applying to Drydale College take an entrance test. A student is either accepted or rejected or required to take another test with probabilities 0.3, 0.2 and 0.5 respectively. When a student takes a second test the outcomes and probabilities are exactly the same as for the first test. A student who has to take a third test is accepted with probability 0.25 and rejected with probability 0.75.

(a) Draw a tree diagram to illustrate this information, showing all the probabilities. [2]

(b) Find the probability that a randomly chosen student who applies to Drydale College is accepted. [2]

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162. Question part 2/2 | 9709 May-June 2025 P5 V5 Q4

(c) Find the probability that a randomly chosen student who applies to Drydale College takes at least two tests given that the student is accepted. [3]

Three friends apply to Drydale College.

(d) Find the probability that all three are rejected. [2]

163. Question | 9709 Oct-Nov 2025 P5 V1 Q2

2 A fair six-sided dice with faces labelled 1, 2, 3, 4, 5, 6 is thrown repeatedly until a 6 is obtained.

(a) Find the probability that a 6 is obtained for the first time on the 8th throw. [1]

(b) Find the probability that a 6 is obtained for the third time on the 7th throw. [3]

164. Question | 9709 Oct-Nov 2025 P5 V1 Q4

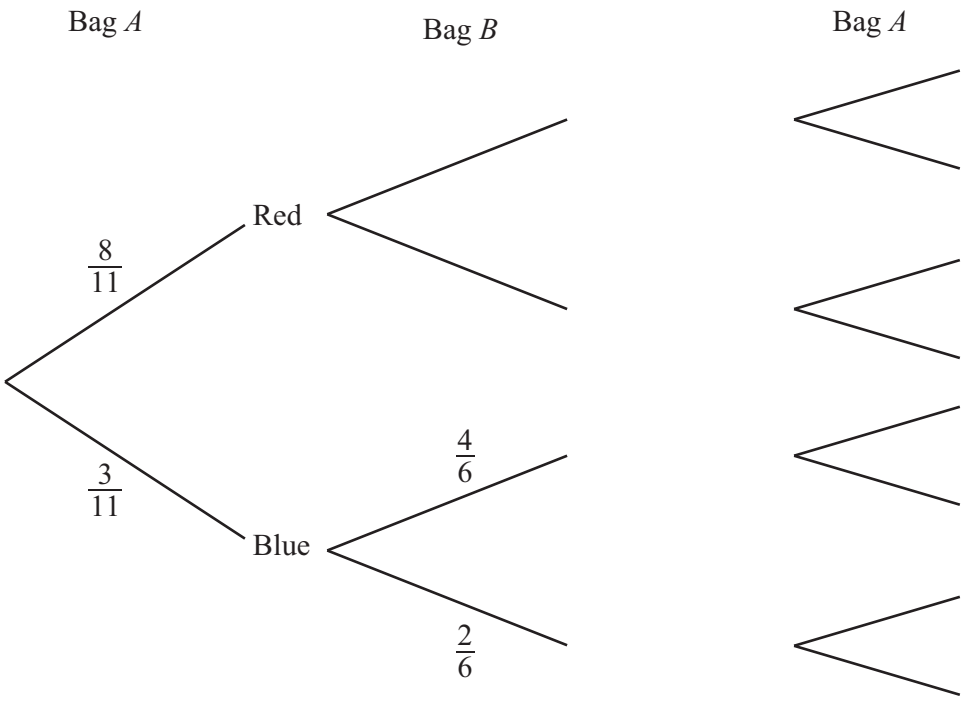
4 Bag A contains 8 red marbles and 3 blue marbles. Bag B contains 4 red marbles and 1 blue marble.

A marble is chosen at random from bag A. If the marble chosen is red, it is discarded. If the marble chosen is blue, it is placed in bag B.

A marble is then chosen at random from bag B. If the marble chosen is red, it is discarded. If the marble chosen is blue, it is placed in bag A.

A marble is now chosen at random from bag A.

(a) Complete the tree diagram below by entering all the remaining outcomes and probabilities. [3]



(b) Find the probability that all three marbles chosen are the same colour. [2]

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165. Question | 9709 Oct-Nov 2025 P5 V1 Q5

5 On any given day, Cooper either wears a blue jumper or he wears a green jumper or he does not wear a jumper. The probability that he wears a blue jumper is 0.6 and the probability that he wears a green jumper is 0.3. Whether Cooper wears a jumper of either colour, or does not wear a jumper, on any day is independent of his choice on any other day.

(a) Find the probability, that in a week (7 days), Cooper wears a blue jumper on at least 5 days. [3]

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(b) Use a suitable approximation to find the probability that, in any 150-day period, Cooper does not wear a jumper on fewer than 22 days. [5]

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166. Question | 9709 Oct-Nov 2025 P5 V2 Q1

1 A coin is biased so that the probability of obtaining a head when it is thrown is 0.4. The coin is thrown repeatedly until the first head is obtained.

(a) Find the probability that the first head is obtained on the 5th throw. [1]

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(b) Find the probability that the first head is obtained after the 6th throw. [2]

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167. Question part 1/2 | 9709 Oct-Nov 2025 P5 V2 Q4

4 Gio has a pack of 18 cards. Ivy has a pack of x cards.

Each card has a picture of a bus or a car or a train. The number of cards with each picture in the two packs is shown in the table.

	Bus	Car	Train
Gio's pack	6	10	2
Ivy's pack	$x-12$	9	3

One card is chosen at random from each pack. The probability that the two cards have pictures of buses on them is equal to twice the probability that the two cards have pictures of cars on them.

(a) Write down an equation in terms of x and hence find the value of x. [4]

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167. Question part 2/2 | 9709 Oct-Nov 2025 P5 V2 Q4

(b) Find the probability that the two cards have pictures of the same type of vehicle on them. [3]

168. Question part 1/2 | 9709 Oct-Nov 2025 P5 V2 Q6

6 For a randomly chosen person, their next birthday is equally likely to occur on any day of the week, independently of any other person's birthday.

(a) Find the probability that, out of 10 randomly chosen people, none of them will have their next birthday on a Saturday or Sunday. [1]

(b) Find the probability that, out of 10 randomly chosen people, fewer than 3 will have their next birthday on a Wednesday. [3]

168. Question part 2/2 | 9709 Oct-Nov 2025 P5 V2 Q6

(c) Use a suitable approximation to find the probability that, out of 392 randomly chosen people, more than 65 will have their next birthday on a Friday. [5]

169. Question | 9709 Oct-Nov 2025 P5 V3 Q1

1 There are a large number of students at Greenfield college. Each student travels to college by car, by bus or on foot, independently of any other student. The probability that any student travels by car is 0.4. The probability that any student travels by bus is 0.35.

(a) 3 students from Greenfield college are selected at random.

Find the probability that none of these 3 students travel to college by car. [1]

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(b) 11 students from Greenfield college are selected at random.

Find the probability that fewer than 9 of these 11 students travel to college by car or by bus. [3]

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170. Question part 1/2 | 9709 Oct-Nov 2025 P5 V3 Q5

5 Chen has three boxes. Box A contains 5 counters, of which 3 are white and 2 are yellow. Box W contains 4 red marbles and 3 blue marbles. Box Y contains 5 red marbles and 3 blue marbles.

Chen chooses one counter at random from box A. If the counter is white, he chooses two marbles from box W, at random and without replacement. If the counter is yellow, he chooses two marbles from box Y, at random and without replacement.

(a) Draw a fully labelled tree diagram to illustrate this information, including all the probabilities. [3]

170. Question part 2/2 | 9709 Oct-Nov 2025 P5 V3 Q5

(b) Find the probability that one red marble and one blue marble are obtained. [3]

(c) Find the probability that a white counter is chosen from box *A*, given that one red marble and one blue marble are obtained. [2]

171. Question | 9709 Oct-Nov 2025 P5 V5 Q1

1 A fair 6-sided dice with faces labelled 1, 2, 3, 4, 5, 6 is thrown repeatedly. The random variable X denotes the number of throws required to obtain a 6.

(a) Find $\mathrm{P}(X = 7)$. [1]

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(b) Find $\mathrm{P}(3 \leqslant X \leqslant 5)$. [2]

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172. Question part 1/2 | 9709 Oct-Nov 2025 P5 V5 Q3

3 Priti has two bags of discs, X and Y.

Bag X contains 8 red discs and 7 blue discs.

Bag Y contains 6 red discs and 9 blue discs.

Priti tosses a fair coin.

If she obtains a head, she chooses at random and **without** replacement two discs from bag X.

If she obtains a tail, she chooses at random and **with** replacement two discs from bag Y.

(a) Draw a tree diagram to represent this information, showing all the probabilities. [2]

172. Question part 2/2 | 9709 Oct-Nov 2025 P5 V5 Q3

(b) Find the probability that the two discs that Priti chooses are blue. [2]

(c) Find the probability that the two discs that Priti chooses come from bag X given that at least one of the discs is red. [4]