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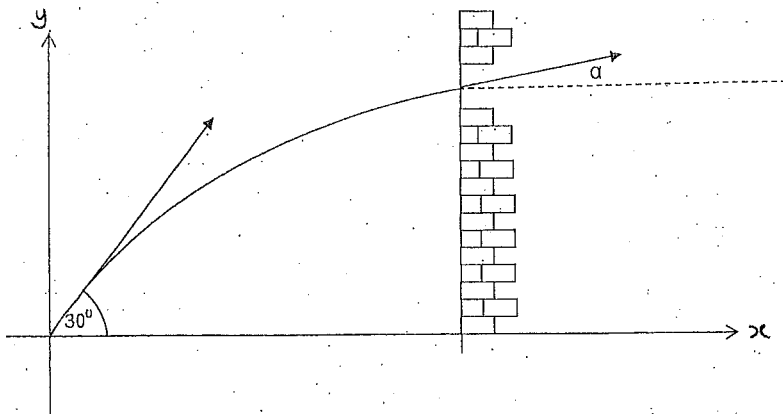
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Question 1 (13 marks) Projectile Motion

1. A particle is projected with an initial velocity of 60ms^{-1} at an angle of 45° to the horizontal. The equations of motion in the horizontal and vertical directions are $\ddot{x} = 0$, $\ddot{y} = -10$ (use $g = 10\text{ms}^{-1}$).
 - i) Derive expressions for \dot{x} , \dot{y} , x and y 4
 - ii) Calculate the greatest height reached by the particle 2
 - iii) What is the speed of the particle at the greatest height? 1
 - iv) What is the horizontal range of the particle? 2

2. A ball is hit with a velocity of 15ms^{-1} at an angle of 30° to the horizontal.



You may assume the following equations of motion.

$\ddot{x} = 0$ $\dot{x} = \frac{15\sqrt{3}}{2}$ $x = \frac{15\sqrt{3}}{2}t$	$\ddot{y} = -10$ $\dot{y} = -10t + 7.5$ $y = -5t^2 + 7.5t$
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- Find:
- i) The height it will strike a wall 10m distant? 2
 - ii) α , the angle at which the ball hits the wall. 2

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Question 2 (12 marks) Permutations and Combinations

1. In how many ways can the letters of the word SASSAFRAS be arranged? 2

2. 12 different coloured beads are arranged around a necklace. How many different arrangements are possible? 1

3. A committee of 8 members consists of one married couple together with 4 other men and 2 other women. From the committee a working party of 4 persons is formed.
 - a) How many different working parties be formed? 1
 - b) what is the probability that the working party:
 - i) Will contain 2 men and 2 women? 1
 - ii) Will contain at least one man and at least one woman? 2
 - c) The 8 committee members sit around an octagonal table, their positions being decided by drawing lots. Find the probability of:
 - i) the man sitting next to his wife 2
 - ii) the man sitting opposite his wife 2
 - iii) the 3 women sitting together. 2

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Question 3 (10 marks) Binomial Probability

- a) Tom, a professional Archer, has a $\frac{2}{11}$ chance of hitting a bullseye.
 - i) In a tournament where each Archer takes 12 shots what is the probability that Tom gets 4 bullseyes? 2
 - ii) To make the final, Tom decides he needs at least 10 bullseyes from his 12 shots. What is the probability that Tom WILL NOT make the finals? 3

- b) Mr Sadler is running a game 'Penta-die-tastic' which involves rolling a six sided die five times. There are two ways to win "Penta-die-tastic":
 - Way 1: You pick one number and it comes up more than 4 times
 - Way 2: You pick two numbers and one of them does not appear at all
 - i) Find the probability of Way 1 2
 - ii) Find the probability of Way 2 2
 - iii) Which one is more likely to occur? 1

END OF TEST

1) $\alpha = 45^\circ$
 $v = 60 \text{ m/s}$

$\ddot{x} = 0$
 $\dot{x} = \int 0 dt = C$
 $\dot{x} = 30\sqrt{2}$
 $x = 30\sqrt{2}t + C$
 $C = 0$

$t = 0$
 $x = y = 0$
 $\dot{x} = 60 \cos 45^\circ = \frac{60}{\sqrt{2}} \text{ OR } 30\sqrt{2}$

$\ddot{y} = -10$
 $\dot{y} = -10t + C$
 $30\sqrt{2} = -10(0) + C$
 $\dot{y} = -10t + 30\sqrt{2}$
 $y = -5t^2 + 30\sqrt{2}t + C$
 $t = 0, y = 0$
 $C = 0$

$\ddot{x} = 0$
 $\dot{x} = 30\sqrt{2}$
 $x = 30\sqrt{2}t$

$\ddot{y} = -10$
 $\dot{y} = -10t + 30\sqrt{2}$
 $y = -5t^2 + 30\sqrt{2}t$

ii) At greatest height $\dot{y} = 0$

$-10t + 30\sqrt{2} = 0$
 $t = 3\sqrt{2}$
 then $y = -5(3\sqrt{2})^2 + 30\sqrt{2}(3\sqrt{2}) = 90 \text{ m}$

iii) Speed at any point $v = \sqrt{\dot{x}^2 + \dot{y}^2}$
 BUT since $\dot{y} = 0$ here
 $v = \dot{x} = 30\sqrt{2} \text{ m/s}$

iv) For horizontal range EITHER $t = 2 \times (3\sqrt{2})$ (from ii) OR let $y = 0$ (longer)

then $x = 30\sqrt{2} \times 6\sqrt{2} = 360 \text{ m}$

2/i) $x = 10$
 $\frac{15\sqrt{3}}{2}t = 10$
 $t = \frac{20}{15\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{4\sqrt{3}}{9}$
 then $y = -5t^2 + 7.5t = -5\left(\frac{4\sqrt{3}}{9}\right)^2 + 7.5\left(\frac{4\sqrt{3}}{9}\right) = 2.8 \text{ m (2dp)}$

ii) $\tan \alpha = \frac{\dot{y}}{\dot{x}}$
 $= \frac{-10\left(\frac{4\sqrt{3}}{9}\right) + 7.5}{\left(\frac{15\sqrt{3}}{2}\right)}$

$\alpha = 180^\circ - 52' = 179^\circ 08'$

Q2/1 $\frac{9!}{4! \times 3!} = 2520 \checkmark$

2/ $\frac{11!}{2} = 19958400 \checkmark$

3a) ${}^8C_4 = 70 \checkmark$

b) i) $\frac{{}^5C_2 \times {}^3C_2}{{}^7C_2} = \frac{3}{7} \checkmark$

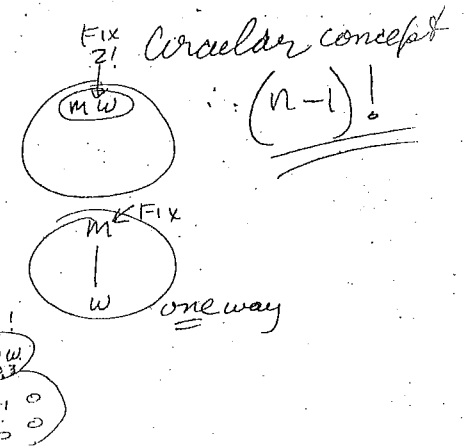
ii) $P(E) = 1 - P(\text{no women}) = 1 - \frac{{}^5C_4}{{}^8C_4} = \frac{13}{14} \checkmark$

Note: Cannot have no men since only 3 women!

C(i) $\frac{2 \times 6!}{7!} = \frac{2}{7}$

(ii) $\frac{6!}{7!} = \frac{1}{7}$

(iii) $\frac{3! \times 5!}{7!}$



Ext 1

Question 3 Solutions

$$a) i) P(4 \text{ bullseyes}) = {}^{12}C_4 \left(\frac{2}{11}\right)^4 \left(\frac{9}{11}\right)^8 = (0.109)$$

$$ii) P(\text{At least 10}) = P(10) + P(11) + P(12)$$

$$\therefore P(\text{Not making the final}) = 1 - [P(10) + P(11) + P(12)]$$

$$= 1 - \left[{}^{12}C_{10} \left(\frac{2}{11}\right)^{10} \left(\frac{9}{11}\right)^2 + {}^{12}C_{11} \left(\frac{2}{11}\right)^{11} \left(\frac{9}{11}\right)^1 \right.$$

$$\left. + {}^{12}C_{12} \left(\frac{2}{11}\right)^{12} \left(\frac{9}{11}\right)^0 \right] = (0.9999982)$$

② for all probabilities correct.

$$b) i) P(\text{More than 4}) = P(5)$$

$$= {}^5C_5 \left(\frac{1}{6}\right)^5 \left(\frac{5}{6}\right)^0 = (2)$$

$$ii) P(\text{Picking two numbers and one not showing up at all})$$

$$= P(\text{Not showing up}) \times 2$$

$$= {}^5C_0 \left(\frac{1}{6}\right)^0 \left(\frac{5}{6}\right)^5 \times 2 = (0.803755)$$

iii) Way 2, as the probability is higher. (1)