ZIAUDDIN UNIVERSITY EXAMINATION BOARD

Mathematics Paper 4

Structured Questions

Model Paper 2025

Time Allowed: 2 hours
Total Marks: 75

You must answer on the question paper.

You must bring a soft pencil (preferably type B or HB), a clean eraser, and a dark blue or black pen. You will also need geometrical instruments.

Calculators are allowed.

Before attempting the paper, write your name, candidate number, centre name, and centre number clearly in the designated spaces.

Instructions for Candidates

- Answer all questions.
- Write your answer to each question in the space provided.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- You must show all necessary working clearly.
- Do not use an erasable pen or correction fluid.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.
- Avoid writing over any barcodes printed on the paper.

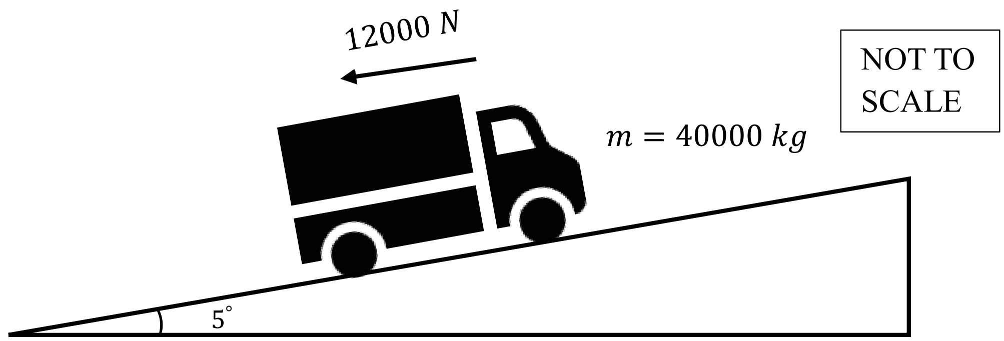
Information for Candidates

- This paper consists of a total of **75 marks**.
- The number of marks assigned for every question or its parts is indicated within brackets [ ].
- A formula sheet will be provided with this paper.

Please read all questions carefully and follow the instructions exactly to ensure your responses are properly evaluated.

Section A: Mechanics

1 A truck of mass $40000\ kg$ travels up a straight incline of angle $5°$ to the horizontal. The resistance to motion is $12000\ N$. The engine produces a constant tractive force $T\ N$.



(a) Write down an expression for the component of the truck's weight acting down the slope.

$w =$ **.................................... [2]**

(b) If the truck moves at constant speed, find the value of T.

$T =$ **.................................... [2]**

(c) The driver increases the tractive force to 22 kN. Find the acceleration.

$a =$ .... **[2]**

(d) Discuss one modelling assumption that may cause the actual acceleration to differ from your calculated value.

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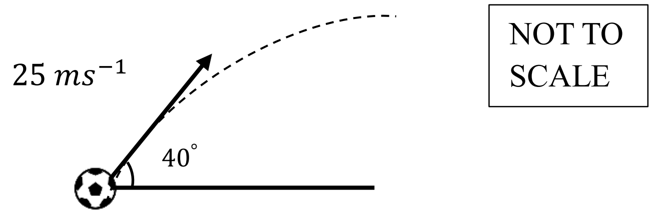
.... **[3]**

2 A ball is projected from ground level with speed 25 $ms^{!}$ at 40°above the horizontal. Neglect air resistance.



(a) Find the horizontal and vertical components of the initial velocity.

u_x=..

u_y=..

[2]

(b) Show that the time of flight is approximately 3.3 s.

$t =$ **.. [3]**

(c) Find the horizontal range of the projectile.

$Range =$ **.. [2]**

(d) State briefly how air resistance would change the range and the shape of the trajectory.

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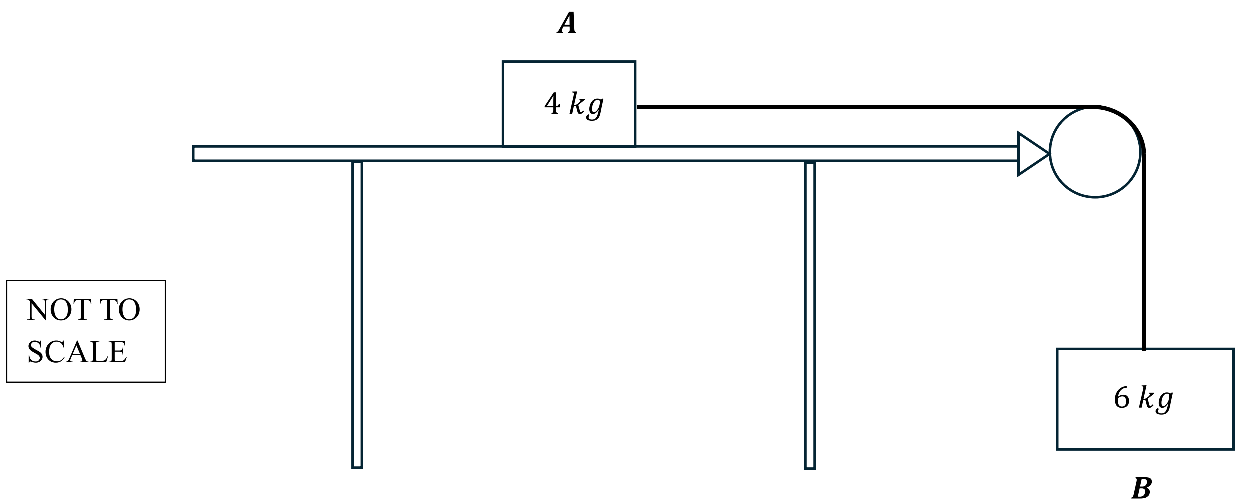
3

Two blocks A(4 kg) and B(6 kg) are connected by a light inextensible string passing over a smooth pulley at the edge of a table. A rests on a smooth horizontal surface, and B hangs freely.



(a) Draw and label all forces acting on each block. **[2]**

(b) Form equations of motion for A and B, and find the acceleration of the system.

$a =$ .... **[3]**

(c) Find the tension in the string.

$T =$ .... **[2]**

(d) Explain how the assumption of a smooth pulley affects the equality of tensions, and what happens if the pulley is rough.

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.... **[1]**

4

A car of mass 900 kg moves at a constant speed of 20 ms^{-1} around a circular track of radius 50 m.

(a) Calculate the magnitude of the resultant (centripetal) force.

F_c=**...[2]**

(b) The road is level and friction provides the necessary centripetal force. Find the coefficient of friction μ.

μ = **...[3]**

(c) Road banked at angle θ so no friction is required at 20 m/s. Find θ.

θ = ...**[3]**

(d) Comment on whether banking improves safety for cars at different speeds.

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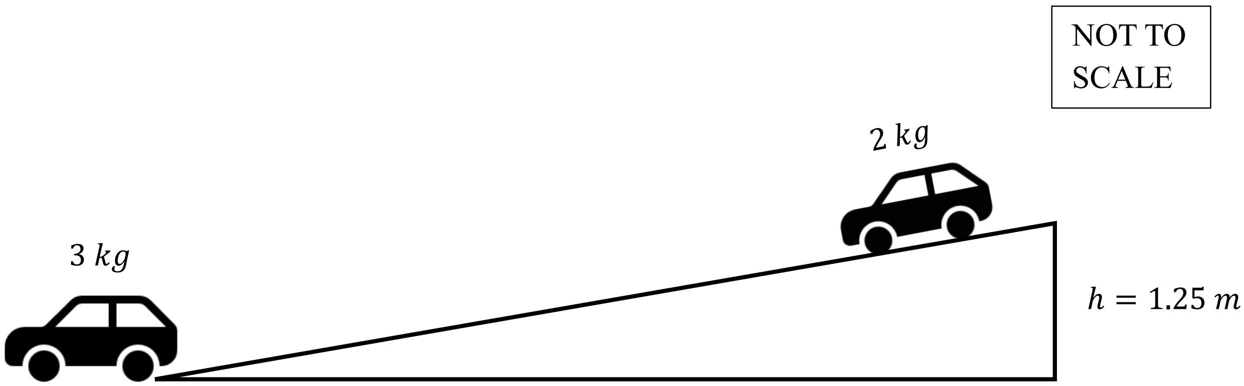
5

A small car of mass $2.0\ kg$ is released from rest at the top of a smooth ramp of height $1.25\ m$. At the bottom it collides with a stationary car of mass $3.0\ kg$. After the collision they move together.



(a) Find the speed of the first car just before impact.

v = ...**[2]**

(b) Find the common speed immediately after the collision.

$v =$ ....**[3]**

(c) Calculate the loss in kinetic energy as a result of the collision.

$Loss =$ .... **[2]**

(d) Give one reason why mechanical energy is not conserved in this collision and state where the 'lost' energy goes.

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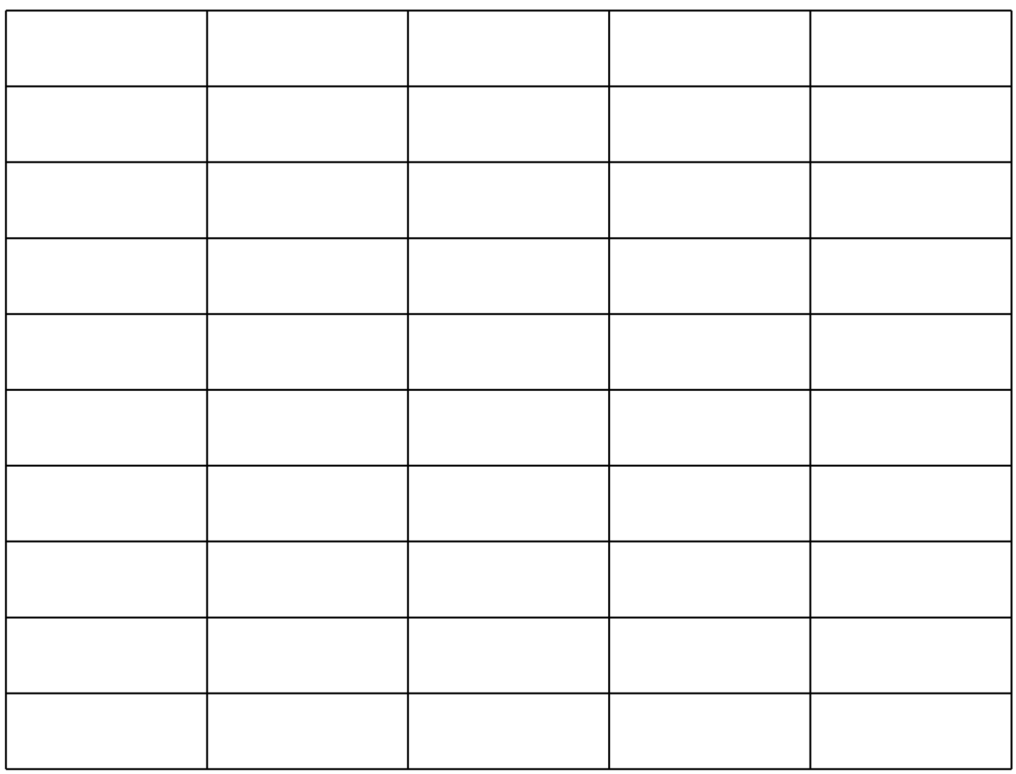
Section B: Statistics

6

The table shows the daily number of cars using a car park during a week.

Day	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Number of cars	240	310	280	330	400	180	150

(a) Label the axes and construct a bar chart to represent the data



[2]

(b) Comment on the trend in car usage across the week.

Comment: ....

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.... **[2]**

(c) Suggest one reason why the number of cars is much lower on Sunday.

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.... **[2]**

7

The table shows the time (in minutes) 40 students spend on homework per day.

Time (min)	**0–20**	**20–40**	**40–60**	**60–80**	**80–100**
Frequency	3	9	16	8	4

(a) Calculate the mean time spent on homework per day.

$Mean =$ ....**[3]**

(b) Find the standard deviation of the distribution.

$\sigma =$ ....**[2]**

(c) State whether the data appear consistent or spread out, with one reason.

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.... **[1]**

8

The test scores of 100 students in an exam are normally distributed with mean $\mu = 65$ and standard deviation $\sigma = 10$.

(a) Using standard normal distribution, find the probability that a randomly chosen student scored between 55 and 75.

$Probability =$ **.. [2]**

(b) Estimate how many students scored above 80.

$Number\ of\ students =$ **.. [2]**

(c) Comment on one limitation of using a Normal Distribution model for actual exam results.

Comment: ....

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.... **[1]**

9

A box contains 6 red, 4 blue, and 5 green balls.
Three balls are drawn without replacement.

(a) Find the probability that all three balls are of different colors.

.... **[2]**

(b) Find the probability that exactly two balls are red.

.... **[2]**

(c) Are the events "all three balls are different colours" and "exactly two balls are red" mutually exclusive? Give a reason.

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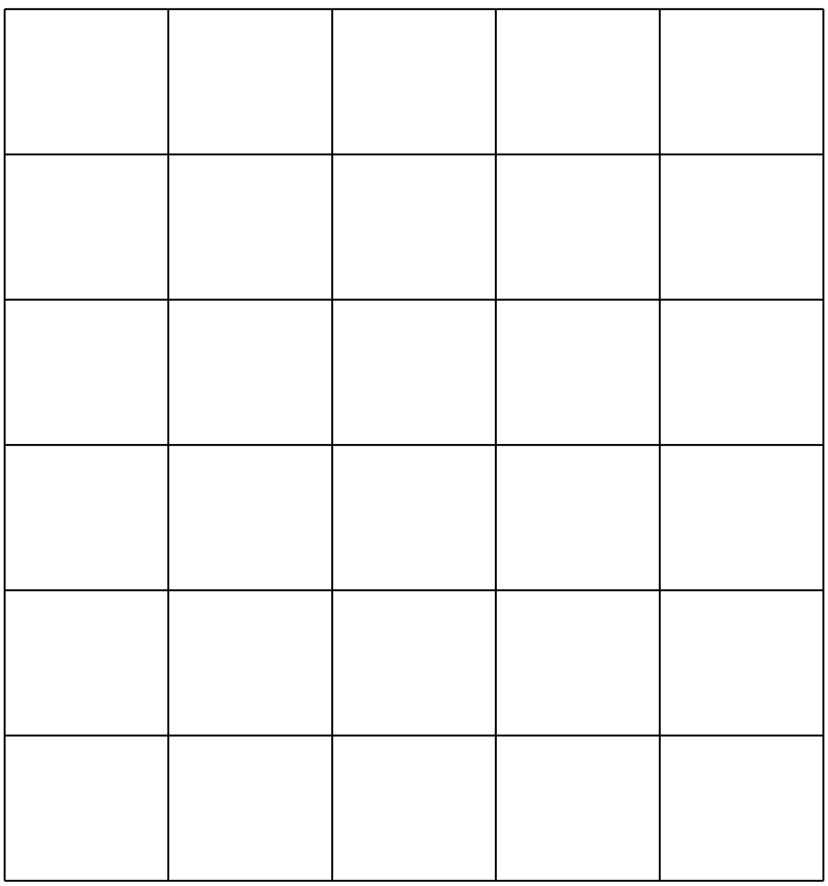
.... **[2]**

10 A fitness researcher records the average number of gym memberships sold per month by chain of gyms, together with the total monthly advertising costs.
The table shows the data collected.

Average memberships sold (per month)	21	39	48	24	72	75	15	35	62	81	12	56
Total monthly advertising costs (in 1000s)	40	58	67	45	89	96	37	53	83	102	35	75

(a) Draw a scatter diagram to represent this data, and label the axes.



[2]

(b) The equation of the regression line of c on m is:

$$c = 21.0 + 0.98m$$

Draw this regression line on your scatter diagram **[1]**

(c) Interpret the meaning of the constants 21.0 and 0.98 in this context.

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(d) The company plans an advertising campaign expecting 74 000 new memberships in June and 95 000 in July.
Comment on the suitability of using this regression line to predict the advertising costs for these months.

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Model Paper 4 Marking Scheme

Section A: Mechanics			
Question		Solution	Notes
Q1	A truck of mass 40000 kg travels up a straight incline of angle 5°to the horizontal. The resistance to motion is 12000 N. The engine produces a constant tractive force T N.		
	(a) Write down an expression for the component of the truck's weight acting down the slope.	Component of weight down slope = $mg\sin\theta$. So, expression: $40000 \times g\sin 5^\circ$ (N). (Accept: $mg\sin 5^\circ$) (numeric evaluation optional here).	**B1** for stating $mg\sin\theta$ or equivalent. **A1** for substituting numbers or leaves as $mg\sin 5^\circ$.
	(b) If the truck moves at constant speed, find the value of T.	For constant speed, resultant force = 0, so $T =$ resistance $+mgsin\ 5°$. Compute: mgsin $5^\circ = 40000 \times 9.8 \times \sin 5^\circ$. $\sin 5^\circ \approx 0.0871557$ → mgsin $5^\circ \approx 392000 \times 0.0871557$ ≈ 34166.9 N. $T = 12000 + 34166.9$ ≈ 46166.9 N $\approx 4.62 \times 10^4$ (Give as 46.2 kN.)	**M1** for correct equation set-up for zero net force **A1** correct value for T
	(c) The driver increases the tractive force to 22 kN. Find the acceleration.	Net force up slope: $T -$ (resistance + mgsin 5°). $= 22000 - 46167$ $= -24167$ N. Acceleration: $a = \frac{F_{\text{net}}}{m} = -\frac{24167}{40000} - 0.604\ \text{m s}^{-2}$ (deceleration.)	**M1** for correct net force expression and substitution. **A1** for correct acceleration
	(d)Discuss one modelling assumption that may cause the actual acceleration to differ from your calculated value.	**Sample answer:** Assume resistance is constant (12 kN) independent of speed. In reality air resistance increases with speed (roughly ~v or v^2), so at higher speed actual resistive force >12 kN. Thus when T is increased to 22 kN the real net force would be *less* than calculated (so the magnitude of acceleration would be smaller).	**B1** for identifying a valid assumption (e.g. resistance constant / no rolling-resistance variation / train treated as particle / neglect engine response). **B1** for stating correct consequence (e.g. actual retarding force may be larger at speed).

			B1 for linking consequence to effect on acceleration (e.g. acceleration would be smaller or more negative)
Q2	A ball is projected from ground level with speed 25 $ms^{!}$ at 40°above the horizontal. Neglect air resistance.		
	(a) Find the horizontal and vertical components of the initial velocity.	$u_x = 25cos40°, u_y = 25sin40°$. $\cos 40° \approx 0.76604$ $\Rightarrow u_x \approx 25 \times 0.7660$ $= 19.15ms^{-1}$ $\sin 40° \approx 0.64279$ $\Rightarrow u_y \approx 25 \times 0.64279$ $= 16.07ms^{-1}$	**M1** for correct trigonometric decomposition **A1** for both components correct to 3 s.f
	(b) Show that the time of flight is approximately 3.3 s.	Time to reach top: $t_{\text{up}} = u_y/g = 16.07/9.8 \approx 1.640s$ Total time $= 2t_{\text{up}} \approx 2 \times 1.640$ $= 3.279 \approx 3.28$ s or 3.3 s).	**M1** for using equation of motion vertically **M1** for substituting numeric values correctly. **A1** for correct final time
	(c) Find the horizontal range of the projectile.	Range $= u_x \times t_{\text{flight}}$ $\approx 19.15 \times 3.279 \approx 62.8$ m	**M1** for using equation of motion horizontally **A1** for numeric range
	(d) State briefly how air resistance would change the range and the shape of the trajectory.	**Sample answer:** Air resistance reduces the horizontal component during flight and increases vertical deceleration, so the range is reduced. The trajectory becomes lower and asymmetric (descent is steeper than ascent) rather than the ideal symmetric parabola.	**B1** for stating effect on range (reduced). **B1** for explaining qualitative change in trajectory shape (lower, asymmetric, steeper descent).
Q3	Two blocks A(4 kg) and B(6 kg) are connected by a light inextensible string passing over a smooth pulley at the edge of a table. A rests on a smooth horizontal surface, and B hangs freely.		
	(a) Draw and label all forces acting on each block.	– On A: weight 3.92×10^1 N down (label $4g$), normal R up, tension T to the right. – On B: weight $6g$ down (label $6g$), tension T up.	**B1** for correct forces on A with right directions. **B1** for correct forces on B with right directions

	(b) Form equations of motion for A and B, and find the acceleration of the system.	Take acceleration of Bdownward = a(so Aaccelerates right with a). For A: $T = m_A a = 4a$. For B: $m_B g - T = m_B a = 6a$. Eliminate T: $6g - 4a = 6a \Rightarrow 6g = 10a$. $$a = \frac{6g}{10}$$ $$= 0.6g = 0.6 \times 9.8$$ $$= 5.88\, m\, s^{-2}.$$	**M1** for writing two correct equations of motion (one for each mass). **M1** for eliminating T and solving algebraically. **A1** for correct acceleration
	(c) Find the tension in the string.	Use $T = m_A a$. $T = 4 \times 5.88 = 23.52$ N. (Or $T = m_B(g - a) = 6(9.8 - 5.88) = 23.52$ N.)	**M1** for correct relation set-up for tension in the string **A1** for correct value of T
	(d) Explain how the assumption of a smooth pulley affects the equality of tensions, and what happens if the pulley is rough.	**Sample Answer:** If the pulley is smooth and massless, tensions either side are equal and no torque/rotational inertia is present. If the pulley is rough or has mass, tensions differ either side → part of the force causes pulley rotation and acceleration will be less (must include rotational equations).	**B1** for correct identification of assumption and one clear consequence (tensions equal when smooth/massless; if pulley rough or massive, tensions differ and acceleration changes).
Q4	A car of mass 900 kg moves at a constant speed of 20 ms^{-1} around a circular track of radius 50 m.		
	(a) Calculate the magnitude of the resultant (centripetal) force.	Centripetal force $F_c = \frac{mv^2}{r}$ $$= \frac{900 \times 20^2}{50} = \frac{900 \times 400}{50}$$ $$= 900 \times 8 = 7200 \text{ N}.$$	**M1** for correct equation for centripetal force **A1** for correct numeric value of F_c
	(b)The road is level and friction provides the necessary centripetal force. Find the coefficient of friction μ.	Frictional force $F_f = \mu R$ with $R = mg = 900 \times 9.8 = 8820$ N. Set $F_f = F_c$: $\mu = \frac{F_c}{mg} = \frac{7200}{8820} \approx 0.8163.$	**M1** for equating correct expressions and making μ the subject **M1** for substituting values correctly. **A1** for correct value of μ
	(c) Road banked at angle θ so no friction is required at 20 m/s. Find θ.	For no friction: horizontal component of normal provides centripetal force:	**M1** for deriving the correct expression for $\tan\theta$ **M1** for substituting

		$N\sin\theta = \frac{mv^2}{r}$ and vertical: $N\cos\theta = mg$. Divide: $\tan\theta = \frac{v^2}{rg} = \frac{400}{50\times9.8} = \frac{400}{490} = 0.8163265$. $\theta = \arctan(0.8163265) \approx 39.1°$.	and computing value. **A1** for correct value of θ
	(d)Comment on whether banking improves safety for cars at different speeds.	**Expected points (any two reasonable points):** • Banking reduces reliance on friction at the design speed (here 20 m/s) — improves safety when tyres/road are slippery. • For speeds greater than design speed, centripetal requirement > horizontal component provided → friction (inward) still needed; risk of skidding outward if friction insufficient. • For lower speeds, friction (outward) may be required to prevent sliding toward centre. • Excessive banking may be uncomfortable or unsafe for very low speeds.	**B1** for one correct observation about how banking affects forces/safety. **B1** for a linked consequence (e.g. need for friction at other speeds, skidding direction, design-speed limitation).
Q5	A small car of mass 2.0 kg is released from rest at the top of a smooth ramp of height 1.25 m. At the bottom it collides with a stationary car of mass 3.0 kg. After the collision they move together.		
	(a) Find the speed of the first car just before impact.	Use energy conservation on smooth ramp: $mgh = \frac{1}{2}mv^2$ $\Rightarrow v = \sqrt{2gh}$. $v = \sqrt{2 \times 9.8 \times 1.25} = \sqrt{24.5} = 4.9497 \ldots \approx 4.95\ ms^{-1}$.	**M1** for using the conceptually right formula to calculate velocity **A1** for correct value of velocity
	(b) Find the common speed immediately after the collision.	Conservation of linear momentum: $m_1u_1 + m_2u_2 = (m_1 + m_2)v'$. $2.0 \times 4.9497 + 3.0 \times 0 = 5.0\, v'$. $v' = \frac{9.8994}{5.0}$ $= 1.97988 \ldots \approx 1.98ms^{-1}$.	**M1** for expressing law of conservation of momentum **M1** for substituting values correctly in the law of conservation of momentum **A1** for correct value of velocity

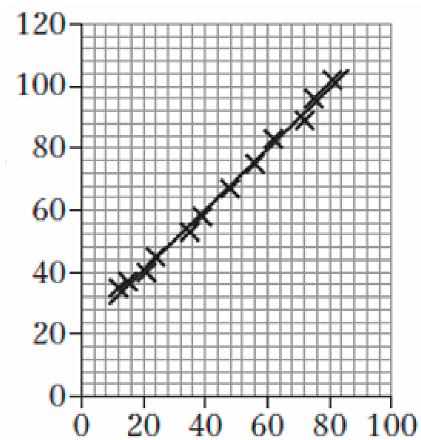
<table>
<tr><td></td><td>(c) Calculate the loss in kinetic energy as a result of the collision.</td><td>KE before = $m_1 gh = 2.0 \times 9.8 \times 1.25 = 24.5\, J$ (or $\frac{1}{2} m_1 v^2$).
KE after = $\frac{1}{2}(m_1 + m_2)v'^2$
$= \frac{1}{2} \times 5.0 \times (1.97988)^2$
= $2.5 \times 3.920 = 9.80\, J$.
Loss = $24.5 - 9.80 = 14.7\, J$
(to 3 s.f.).</td><td>M1 for calculating the initial and final kinetic energies
A1 for correct value of loss (difference)</td></tr>
<tr><td></td><td>(d) Give one reason why mechanical energy is not conserved in this collision and state where the 'lost' energy goes.</td><td>Model answer: Collision is inelastic – kinetic energy is transformed into other forms such as deformation of the cars, sound, heat and internal energy (and possibly slight energy used to overcome internal friction)</td><td>B1 for stating correct reason (inelastic collision / deformation etc.).
B1 for identifying likely destinations of energy (heat, sound, deformation).</td></tr>
<tr><td colspan="4">Section B: Statistics</td></tr>
<tr><td>Q6</td><td>The table shows the daily number of cars using a car park during a week.
<table><tr><th>Day</th><th>Mon</th><th>Tue</th><th>Wed</th><th>Thu</th><th>Fri</th><th>Sat</th><th>Sun</th></tr><tr><td>Number of cars</td><td>240</td><td>310</td><td>280</td><td>330</td><td>400</td><td>180</td><td>150</td></tr></table></td><td></td><td></td></tr>
<tr><td></td><td>(a) Label the axes and construct a bar chart to represent the data</td><td>– Horizontal axis: days Mon, Tue, Wed, Thu, Fri, Sat, Sun.
– Vertical axis: number of cars. Choose a scale that fits 0–400 (e.g. 0, 50, 100, …, 400).
– Draw bars of heights: Mon 240, Tue 310, Wed 280, Thu 330, Fri 400, Sat 180, Sun 150.
– Label axes and give the chart a title.</td><td>B1 for all 7 bars present with correct relative heights (each bar at the correct value or within ±1 small-scale division).
B1 for axes labelled and an appropriate scale chosen (vertical scale covers 0–400 and is uniform).</td></tr>
<tr><td></td><td>(b) Comment on the trend in car usage across the week.</td><td>Sample answer:
There is an increasing trend from Monday (240) to Friday (400) with a peak on Friday, then a sharp drop at the weekend (Sat 180, Sun 150). Weekdays show higher usage (especially Thu–Fri) while weekend usage is much lower.</td><td>M1 for identifying the main trend (increasing Mon→Fri; peak on Fri; drop at weekend).
A1 for a clear conclusion that summarises the trend (e.g. “highest on Friday, much lower on Sun”).</td></tr>
<tr><td></td><td>(c)Suggest one reason why the number of cars is much lower on Sunday.</td><td>Possible answers (any one reasonable reason earns full</td><td>B1 for giving a plausible reason (e.g.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>credit):
– The car park may serve offices or shops that are closed on Sunday, so fewer commuters/customers.
– Local businesses/shops closed or reduced hours; events/working patterns differ on Sunday.
– Public transport patterns or restrictions on Sunday reduce car use.
(Short, plausible real-world explanation expected.)</td><td>offices/shops closed).
B1 for briefly linking it to the observed data (i.e. explain why it produces lower car numbers).</td></tr>
<tr><td>Q7</td><td>The table shows the time (in minutes) 40 students spend on homework per day.
<table>
<tr><th>Time (min)</th><th>0–20</th><th>20–40</th><th>40–60</th><th>60–80</th><th>80–100</th></tr>
<tr><td>Frequency</td><td>3</td><td>9</td><td>16</td><td>8</td><td>4</td></tr>
</table></td><td></td><td></td></tr>
<tr><td></td><td>(a) Calculate the mean time spent on homework per day.</td><td>Step 1 — midpoints:
0–20 → 10;
20–40 → 30;
40–60 → 50;
60–80 → 70;
80–100 → 90.
Step 2 — compute Σf and Σfx:
$f \cdot x$:
3×10 = 30;
9×30 = 270;
16×50 = 800;
8×70 = 560;
4×90 = 360.
Σf = 3+9+16+8+4 = 40.
$\Sigma\, fx$ = 30 + 270 + 800 + 560 + 360 = 2020.
Mean = $\Sigma fx\ /\ \Sigma f$ = 2020 / 40 = 50.5 minutes.</td><td>M1 for using midpoints and set up $\Sigma\, fx$.
M1 for correct sum $\Sigma\, fx$ and Σf
A1 for Correct mean.</td></tr>
<tr><td></td><td>(b) Find the standard deviation of the distribution.</td><td>Use formula for grouped data:
$\sigma = \sqrt{\frac{\Sigma f x^2}{N} - \bar{x}^2}$.
Compute $\Sigma f \cdot x^2$:
$3×10^2 = 300$; $9×30^2 = 8100$;
$16×50^2 = 40000$; $8×70^2 = 39200$;
$4×90^2 = 32400$.
$\Sigma f \cdot x^2$ = 300 + 8100 + 40000 + 39200 + 32400 = 120000.
$$\frac{\Sigma f x^2}{N} = \frac{120000}{40} = 3000.$$
Variance = $3000 - (50.5)^2 = 3000$</td><td>M1 for setting up variance expression correctly (showing substitution).
A1 for correct standard deviation (accept reasonable rounding).</td></tr>
</table>

		− 2550.25 = 449.75. Standard deviation $\sigma =$ $\sqrt{449.75} \approx 21.21 \rightarrow$ **21.2 minutes**	
	(c) State whether the data appear consistent or spread out, with one reason.	**Sample Answer:** The data are fairly **spread out**. The standard deviation (~21.2 min) is large relative to the mean (50.5 min) — about 42% of the mean — indicating wide variation in times.	**B1** for correct judgement (spread out) with a supporting reason (use SD relative to mean or refer to wide class spread).
Q8	The test scores of 100 students in an exam are normally distributed with mean $\mu = 65$ and standard deviation $\sigma = 10$.		
	(a) Using standard normal distribution, find the probability that a randomly chosen student scored between 55 and 75.	Standardise each boundary using $z = \frac{X-\mu}{\sigma}$ For $X = 55$: $z_1 = \frac{55-65}{10} = -1.0$ For $X = 75$: $z_2 = \frac{75-65}{10} = +1.0$ From standard normal tables, $P(Z < 1.0) = 0.8413$ and $P(Z < -1.0) = 0.1587$. $P(55 < X < 75)$ $= 0.8413 - 0.1587$ $= 0.6826$ **Final Answer:** ≈ 0.683	**M1** for correct standardisation process for both bounds or correct z-values found. **A1** for correct probability difference
	(b) Estimate how many students scored above 80.	Standardise: $z = \frac{80-65}{10} = 1.5$. From tables, $P(Z < 1.5) = 0.9332$. So $P(Z > 1.5) = 1 - 0.9332$ $= 0.0668$. Expected number: 100×0.0668 $= 6.68 \approx 7$ students.	**M1** for correctly standardising and identifying $z = 1.5$, sets up $1 - P(Z < 1.5)$. **A1** for correct probability
	(c) Comment on one limitation of using a Normal Distribution model for actual exam results.	Possible valid points (any one): • Exam scores are discrete (0–100) but the Normal model is continuous. • Real data may be skewed (e.g., difficult or easy paper). • Assumes symmetry and infinite range; scores can't be below 0 or above 100.	**B1** for stating any one sensible limitation, e.g. discreteness, skewness, or unrealistic range assumptions.

<table>
<tr><td>Q9</td><td>A box contains 6 red, 4 blue, and 5 green balls.
Three balls are drawn without replacement.</td><td></td><td></td></tr>
<tr><td></td><td>(a) Find the probability that all three balls are of different colours.</td><td>Total balls = 6 + 4 + 5 = 15.
Ways to pick 3 balls of different colours: $6 \times 4 \times 5 = 120$.
Total possible selections $= \binom{15}{3} = 455$.
$$P = \frac{120}{455} = \frac{24}{91} \approx 0.2637.$$</td><td>M1 for correct numerator set-up (correct use of Fundamental Principle of Counting)
A1 for correct final probability (fraction or equivalent decimal)</td></tr>
<tr><td></td><td>(b) Find the probability that exactly two balls are red.</td><td>Choose 2 red from 6: $\binom{6}{2} = 15$.
Choose 1 non-red from 9: $\binom{9}{1} = 9$.
Total favourable $= 15 \times 9 = 135$.
Probability $= \frac{135}{455} = \frac{27}{91} \approx 0.2967$.</td><td>M1 for using combinations correctly for 2 red and one non-red
A1 for correct probability or decimal equivalent</td></tr>
<tr><td></td><td>(c) Are the events “all three balls are different colours” and “exactly two balls are red” mutually exclusive? Give a reason.</td><td>If two balls are red, the third cannot be red, green, and blue simultaneously.
Also, “all different colours” cannot happen if two are the same colour.
→ So the events have no overlap; they are mutually exclusive.</td><td>B1 for recognizing that the events cannot occur together.
B1 for providing reasoning (e.g., two reds prevent all being different colours).</td></tr>
<tr><td>Q10</td><td>A fitness researcher records the average number of gym memberships sold per month by chain of gyms, together with the total monthly advertising costs.
The table shows the data collected.
<table>
<tr><td>Average memberships sold (per month)</td><td>21</td><td>39</td><td>48</td><td>24</td><td>72</td><td>75</td><td>15</td><td>35</td><td>62</td><td>81</td><td>12</td><td>56</td></tr>
<tr><td>Total monthly advertising costs (in 1000s)</td><td>40</td><td>58</td><td>67</td><td>45</td><td>89</td><td>96</td><td>37</td><td>53</td><td>83</td><td>102</td><td>35</td><td>75</td></tr>
</table></td><td></td><td></td></tr>
<tr><td></td><td>(a) Draw a scatter diagram to represent this data, and label the axes.</td><td>Scatter diagram: plot m(1000s) on x-axis, c(£1000s) on y-axis; points should show a strong positive linear relationship.</td><td>B1 for correct axes & scales; variables correctly identified.
B1 for all 12 points plotted within half-square accuracy.</td></tr>
</table>

<table>
<tr><td></td><td>(b) The equation of the regression line of c on m is:
$c = 21.0 + 0.98m$

Draw this regression line on your scatter diagram</td><td>Draw line $c = 21.0 + 0.98m$ on same axes.

</td><td>B1 for regression line correctly positioned (intercept 21 on y-axis, slope ≈ 1).</td></tr>
<tr><td></td><td>(c) Interpret the meaning of the constants 21.0 and 0.98 in this context.</td><td>21.0 → fixed baseline advertising cost (when $m = 0$).
0.98 → for each additional 1 000 memberships, advertising cost increases by £980.</td><td>M1 for identifying intercept meaning (fixed cost).
A1 for identifying gradient meaning (cost per 1 000 memberships).</td></tr>
<tr><td></td><td>(d) The company plans an advertising campaign expecting 74 000 new memberships in June and 95 000 in July. Comment on the suitability of using this regression line to predict the advertising costs for these months.</td><td>$m = 74$ and 95 are within/just beyond the data range (roughly 12–102).
Prediction for 74 000 is within the observed range → interpolation (reliable).
Prediction for 95 000 is near upper limit → borderline extrapolation, so less reliable.</td><td>B1 for identifying interpolation vs extrapolation correctly.
B1 for explaining reliability reasoning.</td></tr>
</table>