Discriminating questions

Compiled by the Queensland Studies Authority

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About this task

These samples demonstrate:

- a range of complexity
- a range of initiative
- the general objectives of Modelling and problem solving
- the general objectives of Communication and justification.

This annotated sample is intended to be a guide to help teachers plan and develop assessment tasks for individual school settings.

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Purposes of assessment

The purposes of assessment are to provide feedback to students and parents about the learning that has occurred and to provide feedback to teachers about the teaching and learning processes. Assessment also provides information on which to base judgments about how well students meet the general objectives of the course.

In designing an assessment program, it is important that the assessment tasks, conditions and criteria be compatible with the general objectives and the learning experiences. Assessment then becomes an integral aspect of a course of study. More information on school-based assessment is available from the QSA website.

Developing assessment tasks

An assessment task is work undertaken by a student in response to an assessment instrument and learning experiences and is outlined in a task sheet. In describing assessment tasks to students, teachers need to ensure that:

- The techniques and instruments chosen allow students to demonstrate achievement in the particular objective or objectives.
- The tasks are written in clear, unambiguous language, thereby ensuring that both the teacher and the student have the same understanding.
- The criteria for both formative and summative assessment always refer to the individual's achievement, even if assessment has involved group work.
- In the assessment of students, the guidelines for quality and equity apply. These are available from the QSA website.
- Task conditions, which are to be consistent with the conditions described in the syllabus, are stated on task sheets.

Data collection and presentation — Skulls

Complexity: high

Initiative: med–high

- Informed decision making
- Recognising strengths and limitations or models

The table on the following page provides data for four measurements (MB, BH, BL and NH) made on male Egyptian skulls from the area of Thebes. There are 30 samples from each of five different periods: 4000 BC, 3300 BC, 1850 BC 200 BC and 150 AD.

Knowledge and procedures

1. You are required to use technology (Microsoft Excel and graphing calculators) to examine the data.
2. Enter all the measurement data into an Excel spreadsheet and use the Excel statistics functions to find a five number summary, mode and range for each measurement. Store these statistics in the spreadsheet.
3. Present the data for the four measurements from the five different time periods in parallel boxplots (e.g. present the MB data from 4000 BC, 3300 BC, 1850 BC, 200 BC and 150 AD in five parallel boxplots. Repeat for BH, BL and NH.
4. Use Excel to calculate the mean and population standard deviation for each variable for each time period. For the period 150 BC, construct scatterplots as follows: MB against BH, MB against BL, MB against NH, BH against NH, and BL against NH. Label each graph clearly and store these in your spreadsheet.
5. What problems are there (if any) with drawing conclusions from this dataset?

Modelling and problem solving

Use the information from *Knowledge and procedures* to decide if any conclusions can be drawn from the data and statistics. Present your conclusions in a statistical report for the Cairo Archaeological Society. Entitle your report “Have the dimensions of skulls altered significantly over the time period 4000 BC to 150 AD?” All graphical evidence, spreadsheets and statistical calculation must be included.

Communication and justification

Grades for *Communication and justification* will be awarded over the two criteria of *Knowledge and procedures* and *Modelling and problem solving.* All graphical evidence, spreadsheets and statistical calculations must be included. To obtain a high level in the criterion *Communication and justification*, explanations must be thorough, clear and correct with the appropriate references to all relevant supporting documentation.

Variables:

MB	maximum breadth across the skull (in mm)
BH	basibregmatic height from the base of the jaw to the top of the skull (in mm)
BL	basialvelar length from the back of the skull to the front (in mm)
NH	nasal height from the jaw to the base of the nose (in mm)
Year	the approximate year from which the skull comes
Period	the approximate period from which the skull comes, either Early Predynastic period, Late Predynastic period, Dyn. 12.13 (dynasties of the 12th and 13th centuries), Ptolemaic period or Roman period

MALE EGYPTIAN SKULL DATA 4 000 BC TO 150 AD

MB	BH	BL	NH	Year	Period
131	138	89	49	-4000	Early Predynastic
125	131	92	48	-4000	Early Predynastic
131	132	99	50	-4000	Early Predynastic
119	132	969	44	-4000	Early Predynastic
136	143	100	54	-4000	Early Predynastic
138	137	89	56	-4000	Early Predynastic
139	130	108	48	-4000	Early Predynastic
125	136	93	48	-4000	Early Predynastic
131	134	102	51	-4000	Early Predynastic
134	134	99	51	-4000	Early Predynastic
129	138	95	50	-4000	Early Predynastic
134	121	95	53	-4000	Early Predynastic
126	129	109	51	-4000	Early Predynastic
132	136	100	50	-4000	Early Predynastic
141	140	100	51	-4000	Early Predynastic
131	134	97	54	-4000	Early Predynastic
135	137	103	50	-4000	Early Predynastic
132	133	93	53	-4000	Early Predynastic
139	136	96	50	-4000	Early Predynastic
132	131	101	49	-4000	Early Predynastic
126	133	102	51	-4000	Early Predynastic
135	135	103	47	-4000	Early Predynastic
134	124	93	53	-4000	Early Predynastic
128	134	103	50	-4000	Early Predynastic
130	130	104	49	-4000	Early Predynastic
138	135	100	55	-4000	Early Predynastic
128	132	93	53	-4000	Early Predynastic
127	129	106	48	-4000	Early Predynastic
131	136	114	54	-4000	Early Predynastic
124	138	101	46	-4000	Early Predynastic
124	138	101	48	-3300	Late Predynastic
133	134	97	48	-3300	Late Predynastic
138	134	98	45	-3300	Late Predynastic
148	129	104	51	-3300	Late Predynastic
126	124	95	45	-3300	Late Predynastic
135	136	98	52	-3300	Late Predynastic
132	145	100	54	-3300	Late Predynastic
133	130	102	48	-3300	Late Predynastic
131	134	96	50	-3300	Late Predynastic
133	125	94	46	-3300	Late Predynastic
133	136	103	53	-3300	Late Predynastic
131	139	98	51	-3300	Late Predynastic
131	136	99	56	-3300	Late Predynastic
138	134	98	49	-3300	Late Predynastic
130	136	104	53	-3300	Late Predynastic
131	128	98	45	-3300	Late Predynastic
138	129	107	53	-3300	Late Predynastic
123	131	101	51	-3300	Late Predynastic
130	129	105	47	-3300	Late Predynastic
134	130	93	54	-3300	Late Predynastic
137	136	106	49	-3300	Late Predynastic
126	131	100	48	-3300	Late Predynastic
135	136	97	52	-3300	Late Predynastic
129	126	91	50	-3300	Late Predynastic
134	139	101	49	-3300	Late Predynastic
131	134	90	53	-3300	Late Predynastic
132	130	104	50	-3300	Late Predynastic
130	132	93	52	-3300	Late Predynastic
135	132	98	54	-3300	Late Predynastic
130	128	101	51	-3300	Late Predynastic
137	141	96	52	-1850	Dyn. 12.13
129	133	93	47	-1850	Dyn. 12.13
132	138	87	48	-1850	Dyn. 12.13
130	134	106	50	-1850	Dyn. 12.13
134	134	96	45	-1850	Dyn. 12.13
140	133	98	50	-1850	Dyn. 12.13
138	138	95	47	-1850	Dyn. 12.13
136	145	99	55	-1850	Dyn. 12.13
136	131	92	46	-1850	Dyn. 12.13
126	136	95	56	-1850	Dyn. 12.13
137	129	100	53	-1850	Dyn. 12.13
137	139	97	50	-1850	Dyn. 12.13

136	126	101	50	-1850	Dyn. 12.13	141	131	97	53	-200	Ptolemaic
137	133	90	49	-1850	Dyn. 12.13	130	131	98	53	-200	Ptolemaic
129	142	104	47	-1850	Dyn. 12.13	133	128	92	51	-200	Ptolemaic
135	138	102	55	-1850	Dyn. 12.13	138	126	97	54	-200	Ptolemaic
129	135	92	50	-1850	Dyn. 12.13	131	142	95	53	-200	Ptolemaic
134	125	90	60	-1850	Dyn. 12.13	136	138	94	55	-200	Ptolemaic
138	134	96	51	-1850	Dyn. 12.13	132	136	92	52	-200	Ptolemaic
136	135	94	53	-1850	Dyn. 12.13	135	130	100	51	-200	Ptolemaic
132	130	91	52	-1850	Dyn. 12.13	137	123	91	50	150	Roman
133	131	100	50	-1850	Dyn. 12.13	136	131	95	49	150	Roman
138	137	94	51	-1850	Dyn. 12.13	128	126	91	57	150	Roman
130	127	99	45	-1850	Dyn. 12.13	130	134	92	52	150	Roman
136	133	91	49	-1850	Dyn. 12.13	138	127	86	47	150	Roman
134	123	95	52	-1850	Dyn. 12.13	126	138	101	52	150	Roman
136	137	101	54	-1850	Dyn. 12.13	136	138	97	58	150	Roman
133	131	96	49	-1850	Dyn. 12.13	126	126	92	45	150	Roman
138	133	100	55	-1850	Dyn. 12.13	132	132	99	55	150	Roman
138	133	91	46	-1850	Dyn. 12.13	139	135	92	54	150	Roman
137	134	107	54	-200	Ptolemaic	143	120	95	51	150	Roman
141	128	95	53	-200	Ptolemaic	141	136	101	54	150	Roman
141	130	87	49	-200	Ptolemaic	135	135	95	56	150	Roman
135	131	99	51	-200	Ptolemaic	137	134	93	53	150	Roman
133	120	91	46	-200	Ptolemaic	142	135	96	52	150	Roman
131	135	90	50	-200	Ptolemaic	139	134	95	47	150	Roman
140	137	94	60	-200	Ptolemaic	138	125	99	51	150	Roman
139	130	90	48	-200	Ptolemaic	137	135	96	54	150	Roman
140	134	90	51	-200	Ptolemaic	133	125	92	50	150	Roman
138	140	100	52	-200	Ptolemaic	145	129	89	47	150	Roman
132	133	90	53	-200	Ptolemaic	138	136	92	46	150	Roman
134	134	97	54	-200	Ptolemaic	131	129	97	44	150	Roman
135	135	99	50	-200	Ptolemaic	143	126	88	54	150	Roman
133	136	95	52	-200	Ptolemaic	134	124	91	55	150	Roman
136	130	99	55	-200	Ptolemaic	132	127	97	52	150	Roman
134	137	93	52	-200	Ptolemaic	137	125	85	57	150	Roman
131	141	99	55	-200	Ptolemaic	129	128	81	52	150	Roman
129	135	95	47	-200	Ptolemaic	140	135	103	48	150	Roman
136	128	93	54	-200	Ptolemaic	147	129	87	48	150	Roman
131	125	88	48	-200	Ptolemaic	136	133	97	51	150	Roman
139	130	94	53	-200	Ptolemaic						
144	124	86	50	-200	Ptolemaic						

Data collection and presentation — Travelling to work

A worker, travelling in Brisbane, has two alternative routes to work. Both routes have many sets of traffic lights. Over 8 journeys on each route, the times spent waiting at lights, in minutes, were recorded.

Route 1	16	15	15	13	14	16	18	13
Route 2	15	15	10	18	20	14	11	15

Complexity: med–high

Initiative: med

- Informed decision making
- Initiative and insight

1. Calculate the mean and standard deviation of each route.
2. When driving to work, it takes exactly 24 minutes driving time plus the time spent at the lights. What is the average time to get to work for each route?
3. On a particular day, the worker is running late, with only 40 minutes to get to work. The worker does not want to be late, and being very late is even worse. Which route should be taken? Explain your answer in detail, using statistical methods.

Caution: Calculation of standard deviation by the long method is not required by the syllabus. The emphasis of the syllabus is on understanding, and use and/or misuse of standard deviation as a descriptor of spread.

Data collection and presentation — Using graphs

You are the director of a company and you have given large salary increases to all your staff during 2008. However, profits have not been a spectacular as in 2007 The table below gives the figures for the mean profits and salaries for each quarter (three months) of 1999.

For the annual general meeting of the shareholders you are to draw two graphs, one showing profits, the other showing salaries, which will show you in the best possible way to shareholders.

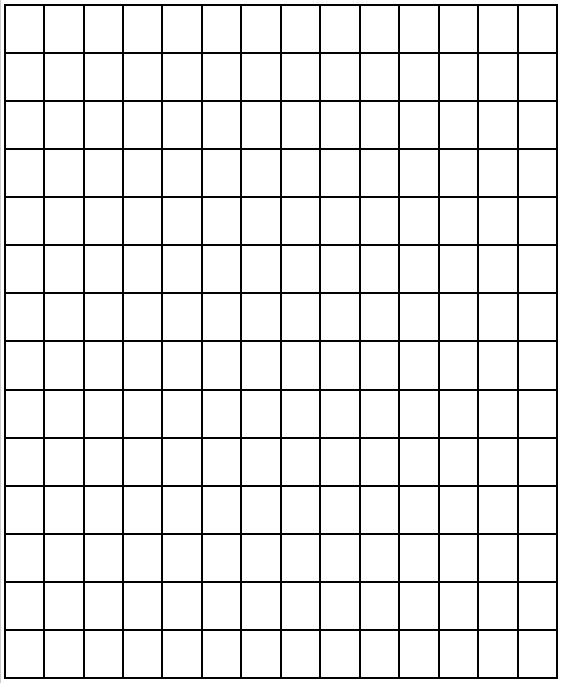
Complexity: med–high

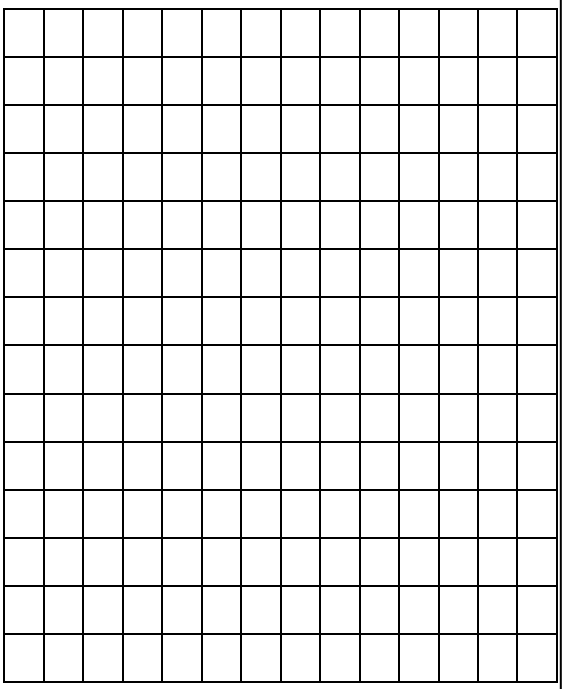
Initiative: high

- Informed decision making

On the grid below **draw the graphs** *and* **explain clearly** why you have drawn them the way you have.

	1st quarter	2nd quarter	3rd quarter	4th quarter
Profits $'000 000	3	2	3	4
Salaries $'000 000	5	5.5	6	6.5





Explanation:

This question could be altered in a variety of ways, e.g. by presenting a number of different graphs of the same data to cater for a variety of purposes.

Elements of applied geometry — House on the hill

Complexity: med

Initiative: med

- Informed decision making

A family wishes to build a house on the top of a hill. They estimate that the distance from their gate, at the foot of the hill, to their house pad is 320 m. (The house pad is the prepared area of flat land where the house will be built.) Using a clinometer (an accurate commercial version of a height measurer), they determine the gradient of the hill to be 30°.

Their problem is water supply.

The local council guarantees a minimum water pressure of 76 hPa at the foot of the hill. The recommended pressure required at the house to provide an adequate water supply is 56 hPa. It is known that water pressure decreases at the rate of 1 hPa per 8 vertical metres rise.

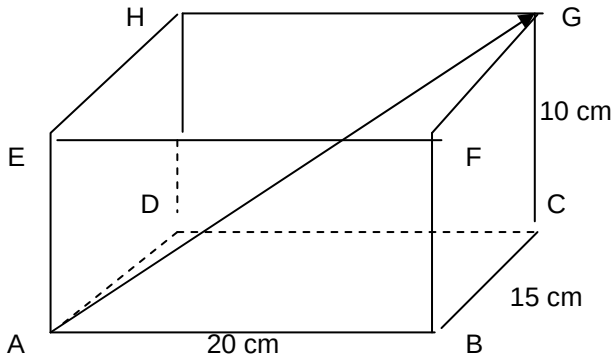
Should the family install a pressure pump to ensure that there will be adequate water pressure at their house?

Elements of applied geometry — Pencil in a box

Complexity: low

Initiative: low

The diagram below represents a wooden pencil box. The pencil box is 20 cm long, 15 cm wide and 10 cm deep.



Find the length of the longest pencil that can fit diagonally from the bottom of one corner to the top of the other corner, as shown by the line drawn from A to G. All edges of the box meet at right angles.

This question has lots of potential for development:

- Leave out the position of the pencil from the diagram (with changed wording)
- Either with or without a diagram, ask the question “Will a 28 cm pencil fit in the box?”
- Ask “How much will need to be cut from a pencil 30 cm long before it will fit in the box?”
- Ask “Does the diagonal of the box give the actual length of the pencil that will fit inside the box?”

Managing money II — Buying a car

Complexity: med–high

Initiative: med–high

- Informed decision making

An eccentric relative will lend you $20 000 interest-free to buy a used car to travel to and from university or college next year, since you live in an area that has few public transport options.

You intend to complete a four-year course and will sell the car immediately after you have finished your studies in order to repay the loan. You do not have to spend all the money.

You could buy a late model used car with an extended warranty and reasonably low running costs, but these cars will depreciate rapidly.

On the other hand, you could buy an older classic or collectable car, which is likely to appreciate in value, but which will not have any warranty and will consume more fuel. You may use a search engine such as Google to find out which makes of cars are considered classic or collectable.

For the purposes of this assignment you can assume that:

1. A car has appreciated in value if the present *Dealer Buy* value is at least 25% more than the cost of the car when new.
2. The rate of inflation over the period of the loan is zero.
3. A car less than 5 years old will depreciate at an average rate of 15% p.a. and one 6 to 10 years old will depreciate at an average rate of 9% p.a.
4. A classic car appreciates at the same rate over the next four years as it has done for the period since it was purchased as new (use the *Dealer Buy* value).

Assume that all cars are in good condition and will need only one regular major service at the *Kmart Service Centre* each year during your period of ownership. You will have to research the cost of these services for the cars that you are interested in as they are priced according to the number of cylinders the motor has. This information can be found by clicking on the name of the car (in red) on the relevant *Autoguide* webpage.

Examine all the information you have gathered and make a decision as to which car you will buy. **Your choice must be justified**, not just on economic grounds, but also with regard to the vehicle's suitability in terms of intended use, parking, garaging, etc.

You must provide evidence of research in the form of web page printouts, emails, faxes or telephone numbers.

This item has great potential but there needs a lot more scaffolding and direction given, e.g. genre for reporting back, and audience.

Further questions could easily be incorporate to extend the problem.

- How will money be paid back?
- What happens to the balance of the $20 000?
- What other things (e.g. roadside assistance, insurance, tyres) need to be considered?

Caution: Ensure websites are available and provide the necessary information.

Managing money II — Inflation

The rate of inflation between 1970 and 1980 averaged 10.4%. A farm was sold in 1970 for $230 000. In 1974 it was sold again for $365 000 and in 1979 it was sold again for $645 000. Change all the proceeds to 1980 dollars and work out which was the best real price.

Complexity: med

Initiative: low–med

- Informed decision making

This question can easily be altered to ask things like:

- If the farmer wished to achieve a profit of x%, when should the farm be sold?
- For what price would the farmer need to sell in 1976, in order to achieve a profit of 50%?
- Compare the selling price of the farm with the rate of inflation.

Managing Money II — Investing

An investor owns 6000 50-cent shares in a media company. These have been paying a steady dividend percentage of 8.82% for a number of years and that is expected to continue. The shares have also maintained a steady market value of $1.47 for some time, so the investor bases the return on investment on the dividend yield rather than the dividend percent.

Complexity: med

Initiative: low

- Informed decision making
- Recognising strengths and limitations of models

The investor also placed $7500 with a credit union six years ago, and this amount has grown to $8800. The investor is prepared to sell the shares or redeem the credit union investment, whichever is the worst performer, in order to have money available. Which one would you advise the investor to keep?

Maps and compasses: Navigation — Holiday Island

Complexity: med

Initiative: high

You are part of a team of people who have been asked to provide suggestions on the location of a site for an airstrip and the design of a walking trail.

The following criteria need to be met:

- The plan must include a map of the island showing the position of the airstrip and the scale (all drawn to scale and accurately represented).
- All calculations that were needed are to be shown.
- You must include a written report explaining your plan and how it meets the stated requirements giving the bearing and distance for each leg of the walking trail.

Section A — Airstrip

- Area needs to be flat (e.g. no contour lines running across the area).
- Strip must be at least 50 m wide and 850 m long for the type of aircraft they plan to use to get people to the island.

Section B — Walking trail

The walking trail must:

- be at least 6 km long
- cross water (e.g. creek) at least twice
- go through a rainforest at least once
- involve climbing or descending through steep terrain at least twice (steep terrain is where the slope is 35° or more)
- start and finish at the airstrip you propose to build
- have at least 5 legs
    - one leg of the course needs to pass through at least part of Pandanus Swamp
    - one leg of the course must involve going to Cook's Lookout
- involve walking through some sandy terrain (e.g. along a beach or cay)
- include a place where participants can learn to abseil — the drop must be at least 30 m.

Section C

- Include all necessary calculations.
- Provide a map showing airstrip and walking trail, drawn to scale.
- Give a written report outlining your proposal and the details of your solution.
- Give grid bearings and actual distances for each leg.

This activity, in its current form, requires the use of a map of an island. It can easily be adapted to any area of land.

Networks and queuing — Choose an activity

Tasks

1. Select one of the following projects and research the activities required.
2. Prepare an activity table with estimates of times and prerequisites.
3. Draw a project network.
4. Determine the earliest time in which the project can be completed.
5. Determine the slack time of each activity.
6. Determine the critical path.

Complexity: high

Initiative: high

- Informed decision making
- Recognising strengths and limitations of models

Projects

- Construct a dartboard cabinet (or other item as negotiated with your teacher).
- Paint a mural on a blank wall of the school.
- Organise the Year 12 formal.
- Take a school group on a leadership camp to Magnetic Island.
- Plan a project of your own, as negotiated with your teacher.

Submit a proposal for your chosen project to an appropriate audience (e.g. the school administration, school council) in the form of a report. Follow the report format outlined below.

Report Format

Title: Give your report a title that clearly states the project chosen.

Aim: Provide a statement that explains your **task** and **purpose**.

Method: Detail the research you undertook that justifies

1. the activities required to complete the project
2. the estimated time taken to complete each activity

Results: Provide:

1. an activity table with estimates of times and prerequisites
2. a project network
3. **evidence** of a forward scan
4. **evidence** of a backward scan
5. **evidence** of how you determined the critical path

Conclusions: Clearly state:

1. the earliest time in which the project can be completed
2. the slack-time of each activity
3. the critical path

Recommendations: In approximately 200 words, summarise the details of your project in everyday language suitable for your audience. You should also highlight the strengths and weaknesses of your model that will influence the success or failure of your project. Aim to convince your audience that this project is worth pursuing.

Networks and queuing — Supermarket queues

Managing a queue at a location such as a supermarket involves two main considerations — customer satisfaction and cost effectiveness. Simulating a queuing situation can identify the effects of various factors that determine the most effective way of managing a queue.

Complexity: med–high

Initiative: med–high

- Informed decision making
- Recognising strengths and limitations of models

Your task

You are to simulate a supermarket queue for 1 hour of peak time so that you can make suggestions for the management of that queue. Use the details provided about the supermarket as the basis of the scenario that you are considering. You are to respond to all questions below.

In a small town, this is the only supermarket (i.e. no competition)

Opening hours: same as Woolworths, Stanthorpe

Number of checkouts: 4

Staff: enough staff (permanent and casual) trained as checkout operators to service all opening times. A roster system applies.

Busiest periods are: Thursday, 10 am until 1 pm

Friday, 3 pm until 5 pm

Saturday, 10 am until 1 pm

At these times, customers arrive quite frequently.

Task questions (and guide to report format)

1. (Introduction) Describe the supermarket 1 hour scenario that you are considering (e.g. time of day), and the management system that you will test (i.e. checkouts/staff available, rules for service, etc.). You must clearly state any assumptions (e.g. the manager does not serve, the checkout can remain idle for no longer than …, service time averages … minutes, 3 customers waiting to be served at 8 am, etc.)
2. (Method)
   a. List all the different factors that will affect the length of a queue in a supermarket.
   b. Choose at least two of these factors (C level response) to simulate a supermarket. Explain how you will simulate each factor (e.g. regular 2 minutes, random role of dice, observe a real queue, use random number tables). Justify your chosen methods.
3. (Results – K&P)
   a. Complete the investigation by simulating the 1 hour of customers arriving and being served, with queues forming.
   b. Record your results in a table *and* a graph.
   c. At 15 minutes, 30 minutes and 45 minutes, calculate how many checkouts should be open to disperse the queue.
4. (Observations K&P) Make at least 5 observations about what happened. You need to consider length of queues, waiting time, serving time, number of checkouts opening/closing, idle time for staff, etc.
5. (Conclusions) Predict the long-term behaviour of this queue given the rules for service and nature of arrivals that you established in Question 1.
6. (Recommendations)
   a. Discuss the efficiency of the management system that you established in Question 1.
   b. Make some recommendations to the manager on how the system can improve so that customer satisfaction *and* the business remain efficient.
   c. Comment on how realistic this simulation is. How would it need to be changed to be more realistic?

Networks and queuing — Takeaway shop

Complexity: med

Initiative: med

- Informed decision making
- Recognising strengths and limitations of models

A small takeaway shop in the city is a favorite lunch spot for office workers. Each weekday the shop has a rush of customers between 12 noon and 2 pm. Presently, only one shop assistant works between these hours and is paid $10 per hour by the owner.

The owner is concerned about increasing staff and customer dissatisfaction, so during a typical lunch hour, the owner made the following notes:

Friday — 12 noon to 1 pm

- *Number of customers arriving at noon: 5*
- *Customers arriving in 4 minute intervals: 4, 2, 0, 3, 4, 3, 5,2, 0, 3, 2, 1, 2, 3*
- *Average service time: 4 minutes*
- *Customers who walk in and see four or more customers waiting tend to walk out and buy lunch from a nearby store*
- *Customers spend, on average, $4.50 on their lunch*

The owner would like you to investigate the profitability of employing more staff during this busy time. In a report, give your recommendation including your calculations, graphs or tables, and issues for consideration.

This question could possibly be developed by linking to Managing money — Look at the $10 per hour being paid. Is this the award rate?

Networks and queuing — Traffic lights

Complexity: high

Initiative: high

- Informed decision making

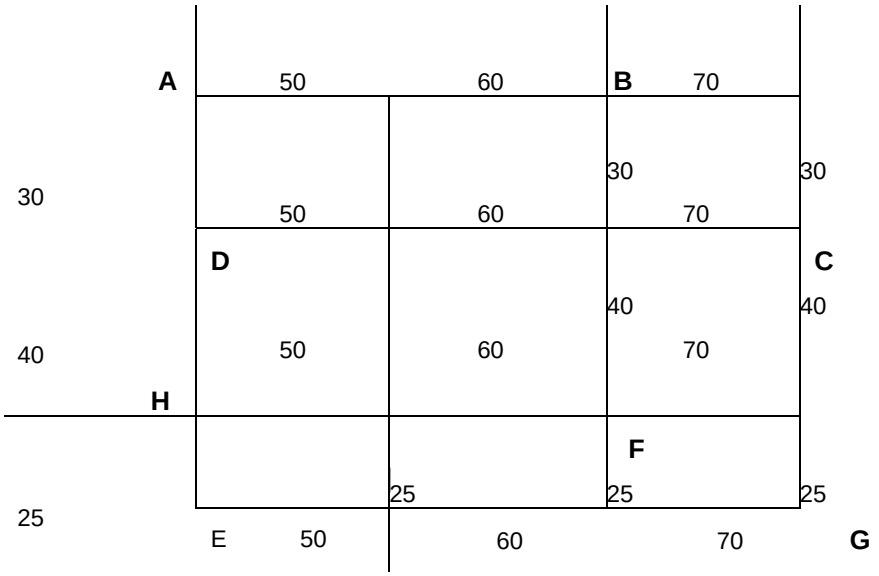
Traffic lights are going to be erected as shown in the diagram below, at intersections A, B, C, D, E, F, G and H. The distance along the blocks is shown in metres. Electricity cables will need to be laid between the traffic lights and in order to minimise costs, the minimum length of cable is required.

Show where the cable should be laid to achieve this minimum and calculate the length of cable required.

Note that:

Cable will need to be laid along the blocks and not cut across them.

The cable from each traffic light must be connected to another traffic light (not merely joined to another cable).



Note: 60 means 60 metres

A bolded letter (such as **H**) indicates a set of traffic lights.