EXPLORERS – PATROL SERVICES

The activities are designed for 60-minute lessons. You may need to adapt the materials for use in longer or shorter lessons.

INTRODUCTION

In this activity, pupils are invited to find a safe route through a notoriously perilous region of space called the Twilight Nebula. They will be faced with a number of different threats but can maximise their chances of survival using a series of threat assessment readouts.

Pupils will compare fraction, decimal and percentage-based probabilities to evaluate the threats arising in the nebula. They will also need to form judgements on the probability of combined events in order to identify those routes offering the greatest chance of survival.

This activity is mainly ICT-based.

LEARNING OBJECTIVES

Pupils will:
- use mathematical problem solving skills in collaboration with each other
- use the multiplicative law of probability in combined events
- use an experimental method to find an estimate of a probability.

LEARNING OUTCOMES

Most pupils will:
- collaborate within their groups to address the problem
- compare probabilities in different forms using mental or pencil and paper methods
- emerge with a final survival rate around the set target
- evaluate their strategies and report back to the class.

Pupils making slower progress will:
- collaborate within their groups to address the problem
- compare probabilities in different forms using calculator methods
- emerge with a final survival rate working towards the set target
- evaluate their strategies and report back to the class.

Pupils making faster progress will:
- collaborate within their groups to address the problem
- compare probabilities in different forms using mental methods
- emerge with a final survival rate exceeding the set target
- evaluate their strategies and report back to the class.

NATIONAL CURRICULUM OBJECTIVES

Ma4 Handling data

Using and applying handling data

1) Pupils should be taught to:

d) review progress as they work; check and evaluate solutions
h) apply mathematical reasoning, explaining and justifying inferences and deductions.

Processing and representing data

4) Pupils should be taught to:
d) understand and use estimates or measures of probability from theoretical models, including equally likely outcomes, or from relative frequency.

Interpreting and discussing results

5) Pupils should be taught to:
h) use the vocabulary of probability in interpreting results involving uncertainty and prediction
i) compare experimental data and theoretical probabilities
j) understand that if they repeat an experiment, they may - and usually will - get different outcomes, and that increasing sample size generally leads to better estimates of probability and population characteristics.

Links to the revised Programme of Study for introduction in 2008 include:

1 Key concepts

Creativity
b) Using existing mathematical knowledge to create solutions to unfamiliar problems.

Applications and implications of mathematics
b) Understanding that mathematics is used as a tool in a wide range of contexts.

2 Key processes

Representing

Pupils should be able to:
a) identify the mathematical aspects of a situation or problem.

Analysing

Pupils should be able to:
b) use knowledge of related problems
g) take account of feedback and learn from mistakes
l) calculate accurately, selecting mental methods or calculating devices as appropriate.

3 Range and content

Number and algebra

The study of mathematics should include:
a) rational numbers, their properties and their different representations.

Statistics

The study of mathematics should include:
d) experimental and theoretical probabilities, including those based on equally likely outcomes.

4 Curriculum opportunities

The curriculum should provide opportunities for pupils to:

a) develop confidence in an increasing range of methods and techniques
e) work on tasks that bring together different aspects of concepts, processes and mathematical content
f) work collaboratively as well as independently in a range of contexts.

LESSON PREPARATION

- Read the teacher notes and familiarise yourself with the other materials.
- Ensure that the activity is available to use on your teacher laptop or desktop computer.
- Ensure that the activity is available for pupils to use, e.g. via school network.
- Arrange for access to an ICT suite.
- Print off enough copies of the accompanying activity sheets.
- You may wish to create a certificate of achievement for pupils that perform well.

Vocabulary

Event, outcome, probability, experimental probability, theoretical probability, frequency, relative frequency.

Materials required

You will need:

- Teacher laptop or desktop computer (to introduce activity)
- Data projector (to introduce activity)
- Access to an ICT suite with enough computers for pupils to work in small groups
- Printed copies of the accompanying activity sheets
  - Captain's Log Sheet
  - Mission Results Sheet
- Calculators (optional)

Prior knowledge and skills

Pupils should already:

- be able to convert decimals and percentages to fractions
- be confident in multiplication of fractions.

Health and Safety

All standard safety procedures with computers need to be in place.

Further information can be found at http://schools.becta.org.uk

LESSON DETAILS

Starter Activity

Project the starter activity onto a whiteboard.

Ask pupils in their groups to list all the ways the coin and the die can land.

Establish that there are 12 possible outcomes.

Discuss the probability of getting a head.

Pupils should be able to answer this question using their list of outcomes.

$$\frac{6}{12} = \frac{1}{2}$$

Discuss the probability of getting a six.

Again, pupils should be able to answer this question using their list of outcomes.

$$\frac{1}{6}$$

Discuss the probability of getting both a head AND a six.

$$\frac{1}{12}$$

Ask pupils to consider the connection between the previous probabilities.

Write the following incomplete calculation on the board.

$$\frac{1}{2} \quad \frac{1}{6} = \frac{1}{12}$$

Ask pupils to identify the operation that is required to make it correct (multiplication).

Annotate the board to show this.

$$\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$$

Discuss the probability of getting either a head OR a six OR both.

$$\frac{7}{12}$$

Ask pupils to consider the connection between the previous probabilities.

Write the following incomplete calculation on the board.

$$\frac{1}{2} \quad \frac{1}{6} \quad \frac{1}{12} = \frac{7}{12}$$

Ask pupils to identify the operations that are required to make it correct (addition and subtraction).

Annotate the board to show this.

$$\frac{1}{2} + \frac{1}{6} - \frac{1}{12} = \frac{7}{12}$$

If time allows, ask the pupils some follow-up questions.

- What is the probability of getting a tail?
- What is the probability of getting a number bigger than 2?
- What is the probability of getting a tail AND a number bigger than 2?
- What do you notice if you multiply the first 2 answers?

Lead into the main activity (see below).

Main Activity

The aim of this activity is to find a safe route through the perilous Twilight Nebula.

The nebula is divided into sectors each containing a different combination of potential threats.

The probability of each threat arising varies greatly from sector to sector.

Pupils will need to:

- assess the likelihood of each threat arising along their chosen route
- customise their ship's defences to counter the potential impact of each threat.

Pupils will receive 'special recognition' if they can:

- find a route offering at least a 50% chance of survival over 20 attempts*.

*We suggest 20 attempts but you may choose to do more or less than this.

This activity is based around an open problem with a complexity of potential interpretations.

Opportunities for discussion and group presentations have been incorporated into the activity.

Pupils should be arranged in small groups at a computer.

With mixed ability classes, try to ensure that each group has an appropriate mix of pupils.

This will help to create appropriate conditions for peer support.

Each group should be given:

- a copy of the 'Captain's Log' sheet
- a copy of the 'Mission Results' sheet.

Introduce the activity by projecting it onto a whiteboard.

Set the scene using the introductory narrative and the Captain's Log sheet to help.

Refer pupils to the 'Getting Started' section on the Captain's Log sheet.

This fleshes out the narrative a little more and provides an introduction to the activity interface.

Allow time for pupils to experiment with the activity as directed.

Once ready, refer pupils to the 'Discussion Time' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow time for pupils to discuss their thoughts and define their strategies.

Try to circulate between groups listening to discussion and asking questions as required.

Encourage pupils to pursue their strategies and to develop the mathematics involved.

Take care, however, not to overly direct the pupils.

Once ready, refer pupils to the 'Recording Your Results' section on the Captain's Log sheet.

Before they can launch, pupils will need to define:
- their preferred route across the map
- their preferred power settings for the front shields, rear shields and life support systems.

Once ready, pupils can click the 'Launch ship' button to proceed.

Once launched, the ship will automatically follow the path that has been defined.

Pupils will be able to track the progress of their ship as it moves across the map.

The ship will sustain damage depending on the number and type of threats that arise.

The ship will be destroyed if the front shields, rear shields or life support systems fall to 0.

Pupils will receive feedback after each attempt based on:
- whether the ship survived or was destroyed
- the status of their front shields, rear shields and life support systems
- the number of power points lost to each type of threat

Ensure that pupils record their results each time in the table on the Mission Results sheet.

Ask pupils to update their survival rate after each attempt.

Pupils should repeat the process until the 'Mission Results' table is complete.

Pupils can then determine if they are deserving of the 'special recognition' award.

Once ready, refer pupils to the 'Finishing Off' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow some time for pupils to discuss their thoughts and reflect on their performance.

If time allows, ask pupils to repeat the process, refining their original strategies.

Lead into the plenary activity (see below).

Plenary

Draw the class together and ask the class to reflect on the activity.

Ask each group to report back on their progress, specifically:
- their chosen route and power settings
- their overall survival rate.

Ask selected groups to describe and evaluate the strategies they used.

In particular, ask them to identify what they would do differently next time.

If time allows, ask pupils some follow-up questions such as:
- What was the key to success in this activity?
- Why did the same route and power settings produce different outcomes each time?

Finally, ask the class to consider the maths that they have used during the activity.

Ask the class to identify real-life contexts where people may use similar maths.

Homework Suggestions

Ask pupils to ensure that they have completed their Captain's Log reflecting on their results and evaluating their performance during the activity as required.

Additionally, pupils could be invited to complete the accompanying homework task sheet. This gives further practice in calculating the probability of combined events.

TECHNICAL SUPPORT

This activity makes use of Flash and Adobe PDF files. To access all the resources that are provided, you will need the minimum machine and software specifications as listed below.

Adobe Flash Player (previously know as Macromedia Flash Player) is required to launch the activity. The latest version of Flash and guidance on how to use it can be downloaded from:

http://www.adobe.com/shockwave/download/download.cgi?P1_Prod_Version=ShockwaveFlash

Adobe Reader or Distiller is required to view these notes. The latest version of Reader and guidance on how to use it can be downloaded from:

http://www.adobe.com/products/reader/

Minimum Machine and Software Specifications

PC

P3 800MHz
128MB RAM
Windows 2000
Screen resolution 1024 x 768
Microsoft Internet Explorer 5.5, Firefox 1, Netscape 7 or Opera 7
Macromedia Flash Player 7
Adobe Reader 7

Mac

G3 500MHz
128MB RAM
OS X 10.2
Screen resolution: 1024 x 768
Safari 1, Firefox 1, Netscape 7, or Opera 6.2
Macromedia Flash Player 7
Adobe Reader 7

Activity 1 Starter

A coin and a six-sided die are thrown at the same time…

1. How many different ways can they land?

2. What is the probability of getting:
   - a head?
   - a six?
   - both a head AND a six?
   - either a head OR a six OR both?

EXPLORERS ACTIVITY 1 - CAPTAIN'S LOG

Your aim in this mission is to find a safe route through the perilous Twilight Nebula.

You will receive special recognition if you can:
- find a route that will give you at least a 50% chance of survival over 20 attempts.

Getting Started

Click on the patrol ship docked at Explorers Space Station to start (see screen shot A below).

Within your group, discuss the information that appears on screen (see screen shot B below).

Experiment with the activity—in particular, observe what happens if you:
- click on the hexagonal sectors in the main display
- click on the up and down arrows at the bottom of the screen
- click on the 'Add sector' button in the bottom corner.

What do you imagine each section of the screen is meant to show?

A)

B)

The 'Launch ship' button will initially be inactive—it will only become active once:
- you have input your chosen route from start to finish
- your front shield, rear shield and life support power settings add up to 100.

Once clicked, your ship will set off on its voyage through the nebula.

The ship will sustain damage depending on the route that is taken and the threats that arise.

The ship will be destroyed if any of the front shield, rear shield or life support settings reach 0.

Discussion Time

Take some time to discuss this problem with the rest of your group.
- How are you going to approach this problem?
- What information will you need to use?
- What overall strategy are you going to employ?

Write your comments in this space.

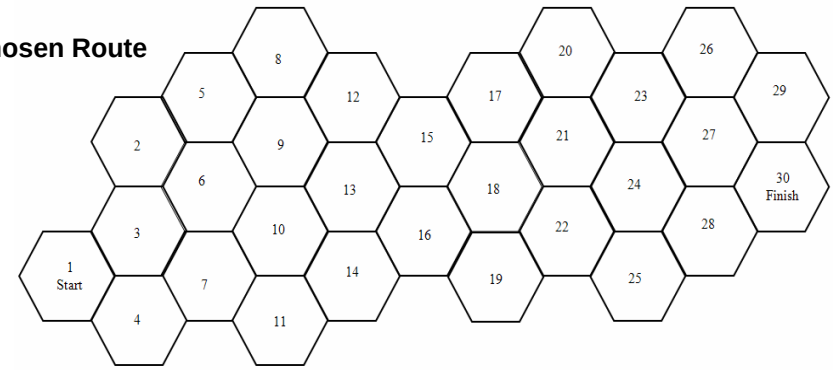
Recording Your Results

Before you attempt to launch, make a note of:

- your chosen route from start to finish (on the outline shown below)
- how you have divided your power points (in the table shown below).

Note that you will not be able to change your route or power settings without starting again.

Chosen Route



Chosen Power Settings

Front Shields	
Rear Shields	
Life Support	

When you are ready, click the 'Launch ship' button to proceed.

Once clicked, track the progress of your ship as it passes through the nebula.

The ship will sustain damage depending on the chosen route and the threats that arise.

The ship will be destroyed if the front shields, rear shields or life support systems fall to 0.

Record your results on the separate sheet repeating the process until the table is complete.

Within your group, discuss your results:

- How would you describe your results?
- Can you see any patterns in your results?
- Is it possible to explain your results?

Describe and attempt to explain your results in this space.

Finishing Off

Now, within your group, discuss the following:

- How satisfied were you with your performance?
- Were the strategies you employed successful?
- How would you do things differently next time?

Write your comments in this space.

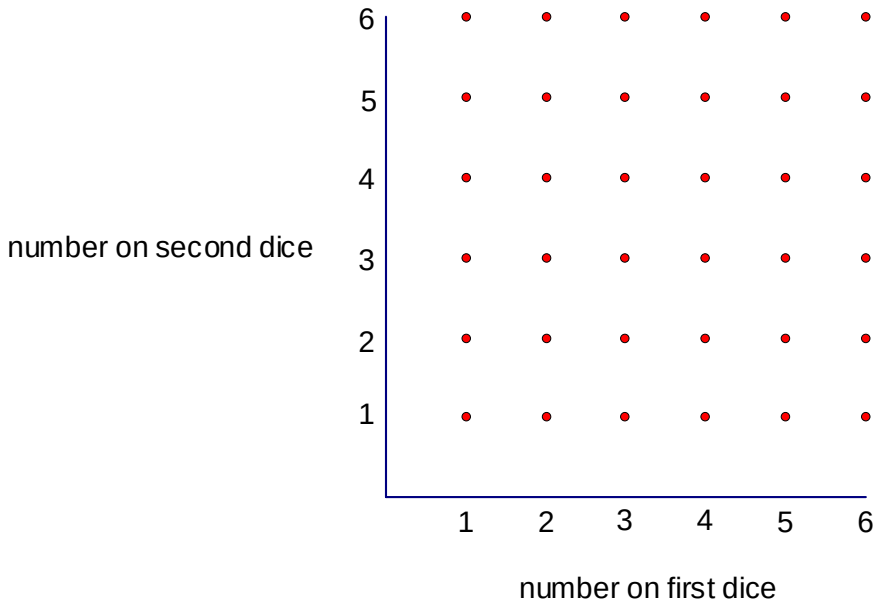
EXPLORERS PATROL SERVICES — RESULTS

Rather you than me… the Twilight Nebula is just about the last place in the universe I'd want to visit.
Still, if you plan your route carefully and use your power points wisely, there's a slim chance you'll make it through.
Record your results every time you launch in the table shown below.
Keep your results safe at the end… you'll need them again soon.

		Power Points Remaining			Power Points Lost				
Attempt Number	Outcome (Survived / Destroyed)	Front Shields	Rear Shields	Life Support	Asteroids	Plasma Rays	Black Holes	Space Pirates	Survival Rate
1									%
2									%
3									%
4									%
5									%
6									%
7									%
8									%
9									%
10									%
11									%
12									%
13									%
14									%
15									%
16									%
17									%
18									%
19									%
20									%

1) Two dice are thrown together.

This diagram shows the number of different ways they can land.



How many different ways can the pair of dice land?

Put a loop around all the dots that represent ways of throwing a six on one die or the other (or both)

Draw another loop around the dots that represent a total of 10

What is the probability of throwing:

a) at least one six?
b) a total of 10?
c) both a 6 and a total of 10?
d) either a 6 or a total of 10 or both?

2) You have a pack of 52 cards.

You pick a card without looking.

What is the probability that you pick:

a) a king?
b) a heart?
c) the king of hearts (how can you check this answer?)
d) either a king or a heart or both?

3) In a particular area of the Twilight Nebula, the probability of being hit by the different threats is shown in the table

Asteroids	Plasma Rays	Black Holes	Space Pirates
10%	$\frac{2}{15}$	0.4	$\frac{3}{8}$

What is the probability that you will be hit by:

a) Asteroids and Black Holes?
b) Plasma Rays and Space Pirates?
c) Asteroids and Plasma Rays and Space Pirates?
d) All four threats?

What is the probability that you will not be hit at all?

EXPLORERS – INTERPLANETARY TRADERS

The activities are designed for 60-minute lessons. You may need to adapt the materials for use in longer or shorter lessons.

INTRODUCTION

In this activity, pupils are invited to trade goods between five planets in a region of space called the Outer Rim. They will be faced with a number of unfamiliar currencies but can maximise their chances of making a profit using the stock market information that is provided.

Pupils will use direct proportion to compare the different currency systems associated with each planet and convert the prices for each good into a common currency. They will also need to manage their budgets, turning their initial allocation of money into a much larger sum.

This activity is mainly paper-based.

LEARNING OBJECTIVES

Pupils will:

- use mathematical problem solving skills in collaboration with each other
- use direct proportion to convert different currencies.

LEARNING OUTCOMES

Most pupils will:

- collaborate within their groups to address the problem
- explore direct proportion in simple contexts using mental or pencil and paper methods
- emerge with a final profit around the set target
- evaluate their strategies and report back to the class.

Pupils making slower progress will:

- collaborate within their groups to address the problem
- explore direct proportion in simple contexts using calculator methods
- emerge with a final profit working towards the set target
- evaluate their strategies and report back to the class.

Pupils making faster progress will:

- collaborate within their groups to address the problem
- explore direct proportion in simple contexts using mental methods
- emerge with a final profit exceeding the set target
- evaluate their strategies and report back to the class.

NATIONAL CURRICULUM OBJECTIVES

Ma2 Number and Algebra

Using and applying number and algebra

1) Pupils should be taught to:

a) explore connections in mathematics to develop flexible approaches to increasingly demanding problems; select appropriate strategies to use for numerical and algebraic problems
b) break down a complex calculation into simpler steps before attempting to solve it
c) use alternative approaches to overcome difficulties and evaluate the effectiveness of their strategies
d) select efficient techniques for numerical calculation and algebraic manipulation
e) make mental estimates of the answers to calculations; use checking procedures to monitor the accuracy of their results.

Numbers and the number system

2) Pupils should be taught to:
g) recognise where fractions and decimals are needed to compare proportions; identify problems that call for proportional reasoning and choose the correct numbers to take as 100% or as a whole.

Equations, formulae and identities

5) Pupils should be taught to:
g) set up and use equations to solve word and other problems involving direct proportion and relate their algebraic solutions to graphical representations of the equations.

Links to the revised Programme of Study for introduction in 2008 include:

1 Key concepts

Competence
a) Applying suitable mathematics accurately within the classroom and beyond.
b) Communicating mathematics effectively.
c) Selecting appropriate mathematical tools and methods, including ICT.

Creativity
b) Using existing mathematical knowledge to create solutions to unfamiliar problems.

2 Key processes

Representing

Pupils should be able to:
a) identify the mathematical aspects of a situation or problem
d) select mathematical information, methods and tools to use.

Analysing

Pupils should be able to:
b) use knowledge of related problems
g) take account of feedback and learn from mistakes.
l) calculate accurately, selecting mental methods or calculating devices as appropriate.

Interpreting and evaluating

Pupils should be able to:
g) consider the effectiveness of alternative strategies.

Communicating and reflecting

Pupils should be able to:
a) communicate findings effectively
b) engage in mathematical discussion of results.

3 Range and content

Number and algebra

The study of mathematics should include:
b) rules of arithmetic applied to calculations and manipulations with rational numbers
c) applications of ratio and proportion.

Geometry and measures

The study of mathematics should include:
g) units, compound measures and conversions.

4 Curriculum opportunities

The curriculum should provide opportunities for pupils to:
a) develop confidence in an increasing range of methods and techniques
e) work on tasks that bring together different aspects of concepts, processes and mathematical content
f) work collaboratively as well as independently in a range of contexts.

LESSON PREPARATION

- Read the teacher notes and familiarise yourself with the other materials.
- Ensure that the activity is available to use on your teacher laptop or desktop computer.
- Print off enough copies of the accompanying activity sheets.
- You may wish to create a certificate of achievement for pupils that perform well.

Vocabulary

Convert**,** conversion**,** currency, exchange rate, proportion, direct proportion, cost price, selling price, profit, loss.

Materials required

You will need:
- Teacher laptop or desktop computer (to introduce activity)
- Data projector (to introduce activity)
- Printed copies of the accompanying materials
    - Planet Profile Sheets
    - Captain's Log Sheet
    - Mission Results Sheet
    - Paper Money
    - Goods Tokens
- Calculators (optional)

Prior knowledge and skills

Pupils should already:

- be familiar with the rounding of decimals to a given number of decimal places.

Health and Safety

All standard safety procedures with computers need to be in place.

Further information can be found at http://schools.becta.org.uk

LESSON DETAILS

Starter Activity

Project the starter activity onto a whiteboard.

Ask pupils in their groups to consider the concept of currencies and exchange rates.

Give pupils sufficient time to calculate the answers to the questions shown on screen.

Ask selected groups to describe how they obtained their answers.

If time allows, ask pupils some follow-up questions.
- How many £ for €8?
- How many € for £25?
- How many $ for £38?
- How many £ for $16?

Ask pupils to consider how many decimal places are sensible when working with money.

Lead into the main activity (see below).

Main Activity

The aim of this activity is to make a profit trading goods between the planets of the Outer Rim.

This can be achieved by buying and selling commodities such as minerals, food, fuel and cloth.

Pupils will only be able to visit each planet once.

Each planet will also have its own unique currency system.

Pupils will need to:
- make sense of the different planetary currencies
- decide which order to visit the planets in
- decide which goods to buy and sell on each planet.

Pupils will receive 'special recognition' if they can:
- find a way to make a profit of more than 10000 Credits .

This activity is based around an open problem with a complexity of potential interpretations.

Opportunities for discussion and group presentations have been incorporated into the activity.

Pupils should be arranged as follows:

- a pair of pupils to represent each of the five Outer Rim planets (the 'planets')
- all remaining pupils to be divided into small groups (the 'crews')

With mixed ability classes, try to ensure that each group has an appropriate mix of pupils.

This will help to create appropriate conditions for peer support.

Each 'planet' group should be given:

- a copy of their planet's 'Trading Profile' sheet
- a mix of trading tokens (Minerals, Food, Fuel, Cloth)
- a pot of paper money (Credits).

Each 'crew' group should be given:

- a copy of the 'Activity 2 - Captain's Log' sheet
- a copy of the 'Activity 2 - Mission Results' sheet
- a copy of each planet's 'Trading Profile' sheet
- a set starting amount of paper money (Credits).

Note that teachers can adjust the challenge presented by this activity in several ways:

- by varying the number of Credits each crew starts with
- by allowing crews to start with a set amount of goods.

The recommended scenario is for each crew to start with 2500 Credits and no goods.

Introduce the activity by projecting it onto a whiteboard.

Set the scene using the introductory narrative and the Captain's Log sheet to help.

Refer pupils to the 'Getting Started' section on the Captain's Log sheet.

This fleshes out the narrative a little more and provides an introduction to the activity interface.

Allow time for all groups to study their 'Trading Profile' sheets as directed.

Refer pupils to the 'Discussion Time' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow time for pupils to discuss their thoughts and define their strategies.

Try to circulate between groups listening to discussion and asking questions as required.

Encourage pupils to pursue their strategies and to develop the mathematics involved.

Take care, however, not to overly direct the pupils.

Once ready, refer pupils to the 'Recording Your Results' section on the Captain's Log sheet.

Highlight that the activity will be divided into a series of five trading rounds.

Explain that crews will have a strictly limited period of planning time between each round.

Emphasise that this planning time needs to be used wisely.

Draw specific attention to the set rules of the activity - as follows:

- each crew to visit each planet only once
- all transactions to take place at the set buy and sell price for each good
- all transactions to take place in Credits only
- no transactions to occur between crews
- all transactions to be recorded on the 'Mission Results' sheet.

Once ready, start the trading activity.

Adjust the length of each planning period and trading round according to the time available.

Begin with a brief planning period in which each crew can plan their initial purchases.

In the meantime, position the planet groups at different points around the classroom.

During each trading round, allow crews to visit their chosen planet.

Crews will hand over Credits for any goods they buy from a planet.

In return, they will receive the corresponding number of trading tokens.

Crews will receive Credits for any goods they sell.

In return, they must hand over the corresponding number of trading tokens.

Ensure that all transactions are recorded on the Mission Results sheet as directed.

At the end of each trading round, ask the crews to return to their desks.

Each crew will then have a limited period of planning time to plan their next move.

Repeat the process until all five trading rounds are complete.

At the end of the activity, draw the class together.

Refer pupils back to the 'Recording Your Results' section on the Captain's Log sheet.

Ask crews to calculate their overall profit.

Pupils can then determine if they are deserving of the 'special recognition' award.

Ask pupils to review their results and consider the questions listed.

Allow time for pupils to discuss their results and record their responses in the space provided.

Once ready, refer pupils to the 'Finishing Off' section on the Captain's Log sheet.

Again, ask pupils to consider the questions listed.

Allow some time for pupils to discuss their thoughts and reflect on their performance.

Lead into the plenary activity (see below).

Plenary

Draw the class together and ask pupils to reflect on the activity.

Ask each group to report back on their progress, specifically:
- their overall profit or loss
- their most or least profitable transactions.

Ask selected groups to describe and evaluate the strategies they used.

In particular, ask them to identify what they would do differently next time.

If time allows, ask pupils some follow-up questions such as:
- What was the key to success in this activity?
- How would it be possible to work out the most profitable route between the planets?

Finally, ask the class to consider the maths that they have used during the activity.

Ask the class to identify real-life contexts where people may use similar maths.

Homework Suggestions

Ask pupils to ensure that they have completed their Captain's Log reflecting on their transactions and evaluating their performance during the activity as required.

Additionally, pupils could be invited to complete the accompanying homework task sheet. This gives further practice in converting between currencies and in using conversion graphs.

TECHNICAL SUPPORT

This activity makes use of Flash and Adobe PDF files. To access all the resources that are provided, you will need the minimum machine and software specifications as listed below.

Adobe Flash Player (previously know as Macromedia Flash Player) is required to launch the activity. The latest version of Flash and guidance on how to use it can be downloaded from:

http://www.adobe.com/shockwave/download/download.cgi?P1_Prod_Version=ShockwaveFlash

Adobe Reader or Distiller is required to view these notes. The latest version of Reader and guidance on how to use it can be downloaded from:

http://www.adobe.com/products/reader/

Minimum Machine and Software Specifications

PC

P3 800MHz
128MB RAM
Windows 2000
Screen resolution 1024 x 768

Microsoft Internet Explorer 5.5, Firefox 1, Netscape 7 or Opera 7
Macromedia Flash Player 7
Adobe Reader 7

Mac

G3 500MHz
128MB RAM
OS X 10.2
Screen resolution: 1024 x 768
Safari 1, Firefox 1, Netscape 7, or Opera 6.2
Macromedia Flash Player 7
Adobe Reader 7

Activity 2 Starter

If … £1 = €1.4

and… £1 = $1.9

1. How much is €1 worth in £?
2. How much is $1 worth in £?
3. How much is €1 worth in $?
4. How much is $1 worth in €?

EXPLORERS ACTIVITY 2 - CAPTAIN'S LOG

Your aim in this mission is to make a profit trading goods between the planets of the Outer Rim.

You will receive special recognition if you can:
• find a way to make a profit of more than 10000 Credits visiting each planet just once.

Getting Started
Listen to the introduction you will receive from your class teacher.

Then study the planet trading profiles that you will have been given.

In particular, think about:
• the different currencies used on each planet
• the relative value of each good on each planet
• the best places to buy and sell each good.

A)

B)

Discussion Time
Take some time to discuss this problem with the rest of your group.
• How are you going to approach this problem?
• What information will you need to use?
• What overall strategy are you going to employ?

Write your comments in this space.

Recording Your Results
The activity will be divided into a series of trading rounds.

Each trading round will be preceded by a period of planning time.

Use your planning time to establish:
• which planet you intend to visit
• which good(s) you intend to buy
• the cost you will pay for the goods you buy
• which good(s) you intend to sell
• the income you will receive for the goods you sell.

Take into account the different currencies used by each planet.

Use the money provided to pay for the goods you buy but don't get ripped off.

As you progress, record your transactions in the summary table on the separate sheet.

Repeat the process each trading round until the table is complete.

Work out how much money you've got at the end and calculate your overall profit.

Within your group, discuss your results:
• How would you describe your results?
• Is it possible to explain your results?

Describe and attempt to explain your results in this space.

Finishing Off
Now, within your group, discuss the following:
• How satisfied were you with your performance?
• Were the strategies you employed successful?
• How would you do things differently next time?

Write your comments in this space.

EXPLORERS INTERPLANETARY TRADERS

This isn't going to be like some kind of starship boot sale… there are serious amounts of money involved.
Plan your route between the planets before each round and remember to buy low and sell high.
Record your transactions every round in the table shown below.
Keep your details safe at the end… you'll need them again soon.

		Amount Of Goods Bought				Amount Of Goods Sold				Credits Available		
	Planet Visited	Mineral	Food	Fuel	Cloth	Mineral	Food	Fuel	Cloth	Cost Of Goods Bought (Credits)	Income From Goods Sold (Credits)	Total Credits
1												
2												
3												
4												
5												

Exchange Rates (June 2007)

Country	£1 is worth	Country	£1 is worth
Argentina	5.9 Pesos	Malaysia	6.6 Ringgit
Canada	2.0 Dollars	New Zealand	2.5 Dollars
Denmark	10.7 Krone	Pakistan	120.9 Rupees
India	72.2 Rupees	Poland	5.1 Zloty
Japan	239.8 Yen	Tunisia	2.4 Dinar
All amounts rounded to 1 decimal place			

1) Use the Exchange Rate table to find the answers to these questions:

   a) What is 1 Canadian Dollar worth in Pence?

   b) How many New Zealand Dollars will you get for £50?

   c) I have £150 to spend on holiday in Poland.
   How much Polish money will I get?

   d) I have 990 Ringgit.
   How much is that in Pounds?

   e) Sukhdev has 18050 Indian Rupees for his trip to the UK.
   How much is that in Pounds?

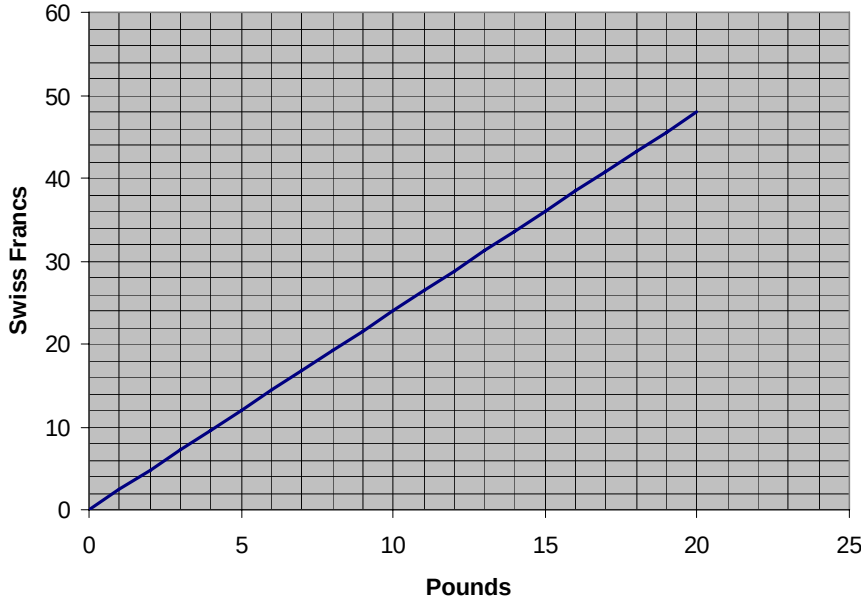
   f) How many Yen will I get for £225?

   g) Mette has 1872.5 Krone to change into Pounds.
   How much will she get?

   h) Abdul is going to Argentina from Tunisia.
   He has 1260 Dinar.
   How many Pesos will he get?

   i) Tegan is travelling from New Zealand to Pakistan.
   She has $NZ900.
   How many Rupees will she get?

2) Look at the conversion graph shown below.



Use the graph to estimate the number of Swiss Francs you will get for:

a) £15
b) £2.50
c) £12.50
d) £19

Use the graph to estimate the number of Pounds you will get for:

f) 30 Swiss Francs
g) 42 Swiss Francs
h) 8 Swiss Francs
i) 43 Swiss Francs

3) Choose any country from the Exchange Rate table.

Calculate what £20 is worth in your chosen country.

Draw a grid with the x-axis from 0 to 20 and the y-axis from 0 to your last answer.

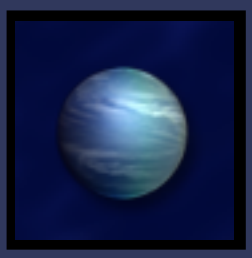
Calculate how much you will get in your chosen currency for £5 and £10.

Draw a conversion graph.

Use your graph to estimate what you will get in your chosen currency for:

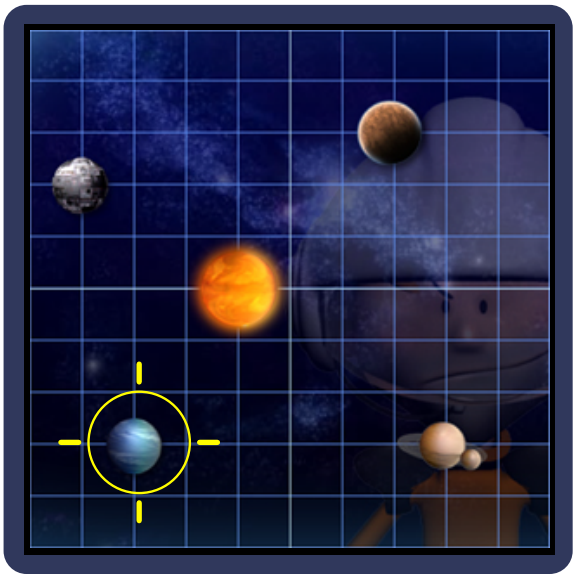
a) £18
b) £12
c) £24
d) £7.50

Tapoona



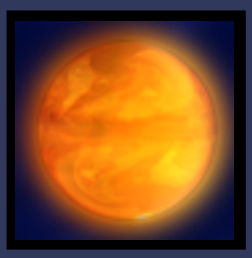
Atmosphere: Oxygen
Population: 12.5 billion
Main Industry: Chemicals

Currency Unit: Oona
Exachange rate: 0.36 Oonas = 1 Eron



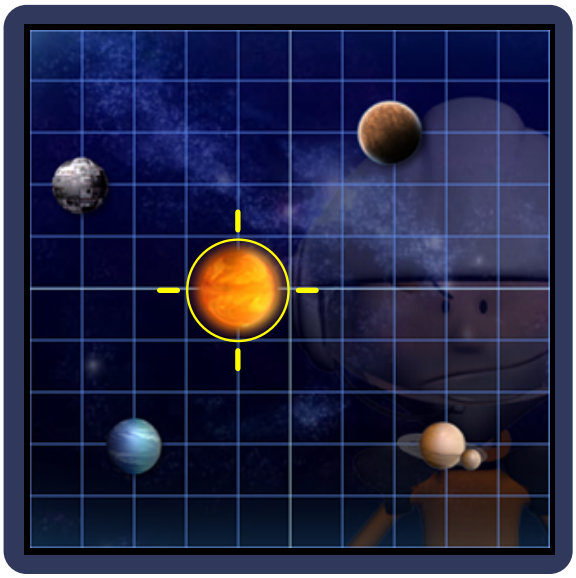
	Buy	Sell
Minerals:	5850 Oonas	5625 Oonas
Food:	5400 Oonas	4950 Oonas
Fuel:	4500 Oonas	4320 Oonas
Cloth:	6300 Oonas	5400 Oonas

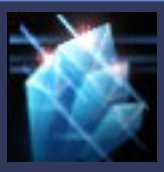
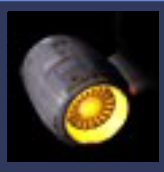
Pravit



Atmosphere: Nitrogen
Population: 2.9 million
Main Industry: Banking

Currency Unit: Avit
Exachange rate: 1 Avit = 25 Credits

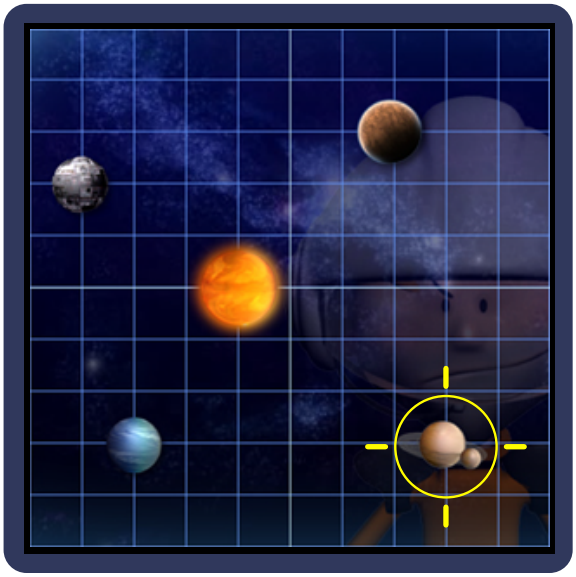


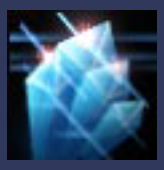
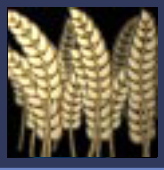
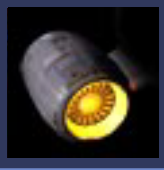
	Buy	Sell
 **Minerals:**	66 Avits	64 Avits
Food:	56 Avits	48 Avits
 **Fuel:**	60 Avits	56 Avits
Cloth:	56 Avits	52 Avits

Galloric

Atmosphere: Hydrogen
Population: 71. billion
Main Industry: Textiles

Currency Unit: Oric
Exachange rate: 120 Orics = 1 Credit

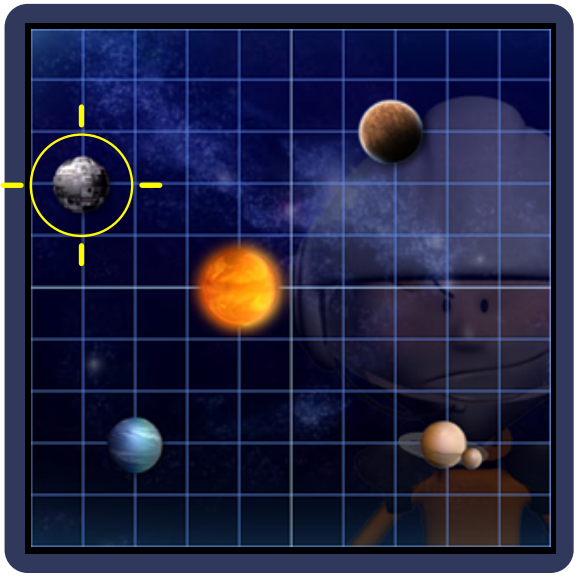


	Buy	Sell
 **Minerals:**	144000 Orics	138000 Orics
 **Food:**	132000 Orics	108000 Orics
 **Fuel:**	180000 Orics	174000 Orics
Cloth:	72000 Orics	60000 Orics

Feron

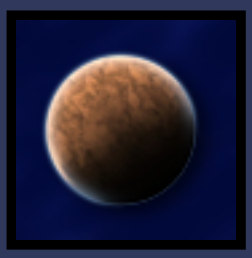
Atmosphere: Nitrogen
Population: 56.4 million
Main Industry: Mining

Currency Unit: Eron
Exachange rate: 12.5 Erons = 1 Credit



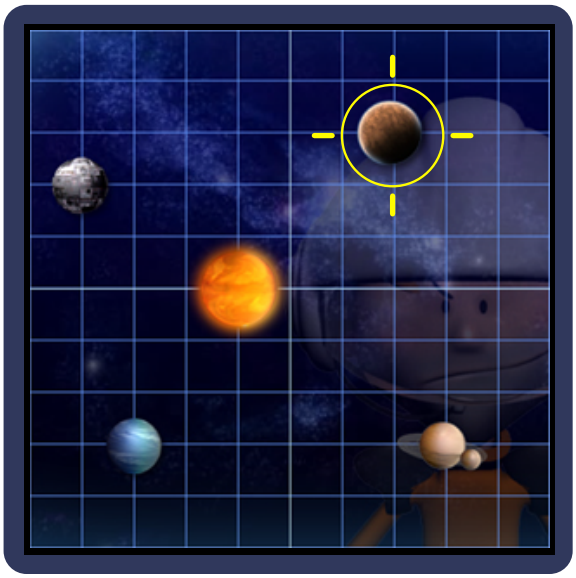
	Buy	Sell
Minerals:	7500 Erons	6250 Erons
Food:	10000 Erons	7500 Erons
Fuel:	21250 Erons	20000 Erons
Cloth:	15000 Erons	13750 Erons

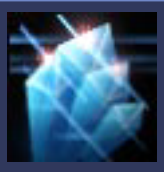
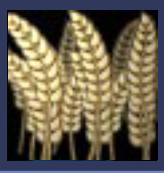
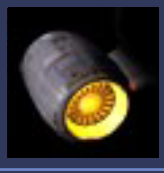
Benjaro



Atmosphere: Oxygen
Population: 1.3 billion
Main Industry: Agriculture

Currency Unit: Jaro
Exachange rate: 20 jaros = 1 Credit



	Buy	Sell
 **Minerals:**	20000 Jaros	18560 Jaros
 **Food:**	30000 Jaros	26000 Jaros
 **Fuel:**	44000 Jaros	42000 Jaros
Cloth:	32000 Jaros	30000 Jaros

500 Credits

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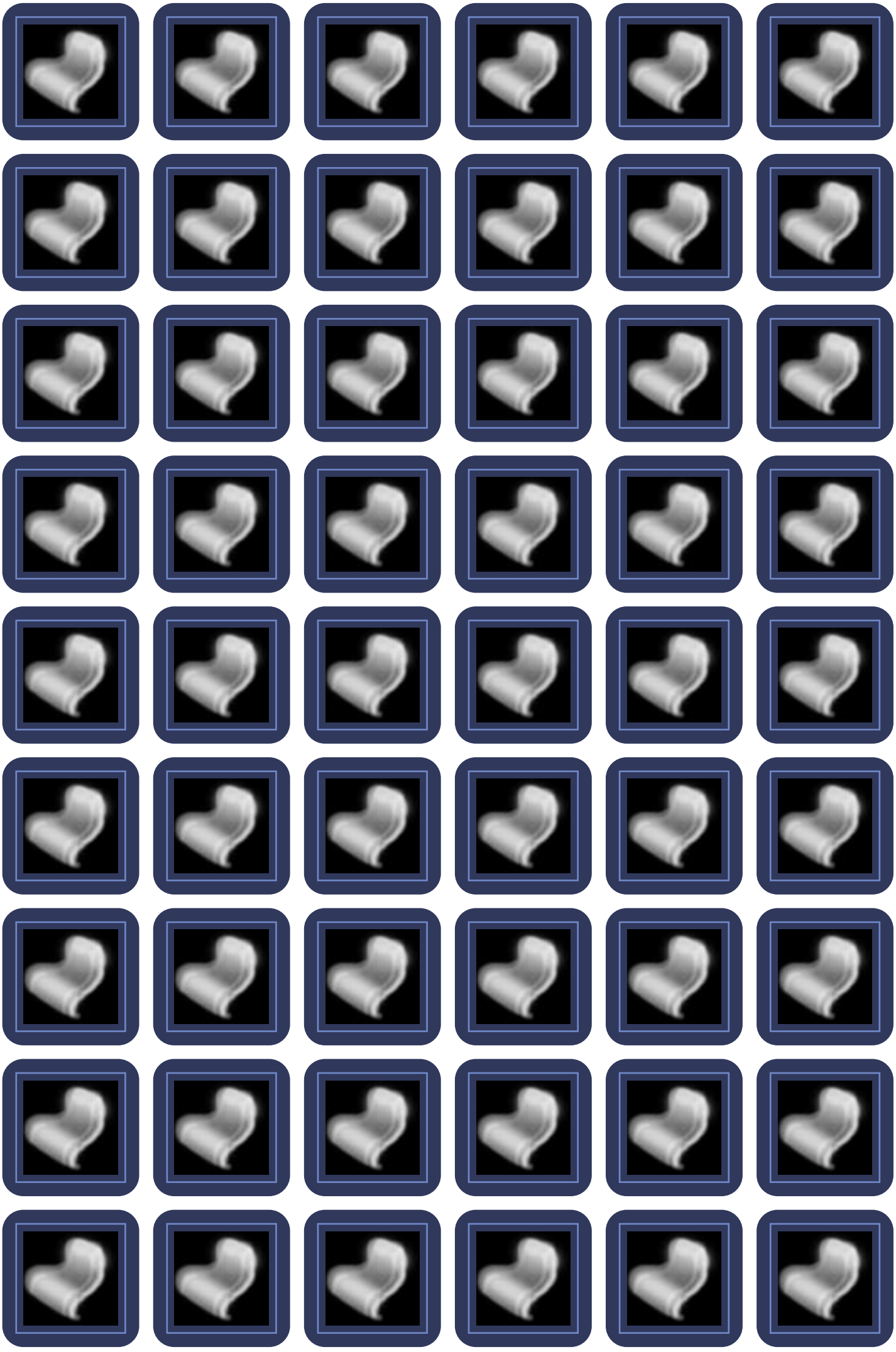


EXPLORERS – MINING ENTERPRISES

The activities are designed for 60-minute lessons. You may need to adapt the materials for use in longer or shorter lessons.

INTRODUCTION

In this activity, pupils are invited to destroy several asteroids blocking the Orbital Highway using a selection of sonic charges. They must place their chosen charges on the correct lines or in the correct regions of a grid representing each asteroid's surface if they are to detonate as required.

Pupils will use linear equations, simple quadratic equations and regions to place their sonic charges in the correct places on the grid. There are three different asteroids to choose from with increasing levels of difficulty based on the complexity of the equations and inequalities used.

This activity is mainly ICT-based.

LEARNING OBJECTIVES

Pupils will:

- use mathematical problem solving skills in collaboration with each other
- use graphs of linear equations and simple quadratic curves
- represent the solution set of an inequality as a region of a graph.

LEARNING OUTCOMES

Most pupils will:

- collaborate within their groups to address the problem
- plot graphs of more complex linear equations and simple quadratic curves
- emerge having destroyed at least the first and second asteroids
- evaluate their strategies and report back to the class.

Pupils making slower progress will:

- collaborate within their groups to address the problem
- plot graphs of simple linear equations
- emerge having destroyed at least the first asteroid
- evaluate their strategies and report back to the class.

Pupils making faster progress will:

- collaborate within their groups to address the problem
- plot graphs of more complex linear equations and simple quadratic curves
- identify regions described by one or more inequalities
- emerge having destroyed all three asteroids
- evaluate their strategies and report back to the class.

NATIONAL CURRICULUM OBJECTIVES

Ma2 Number and algebra

Using and applying number and algebra

1) Pupils should be taught to:

a) explore connections in mathematics to develop flexible approaches to increasingly demanding problems; select appropriate strategies to use for numerical or algebraic problems.

Equations, formulae and identities

5) Pupils should be taught to:

i) solve simple linear inequalities in one variable and represent the solution set on a number line

Sequences, functions and graphs

6) Pupils should be taught to:

e) use the conventions for coordinates in the plane; plot points in all four quadrants; recognise (when values are given for *m* and *c*) that equations of the form y = mx + c correspond to straight-line graphs in the coordinate plane; plot graphs of functions in which *y* is given explicitly in terms of *x* (for example, y = 2x + 3), or implicitly (for example, x + y = 7).

Links to the revised Programme of Study for introduction in 2008 include:

1 Key concepts

Competence

a) Applying suitable mathematics accurately within the classroom and beyond.

2 Key processes

Representing

Pupils should be able to:

a) identify the mathematical aspects of a situation or problem.

Analysing

Pupils should be able to:

a) make connections within mathematics
b) use knowledge of related problems
d) identify and classify patterns
g) take account of feedback and learn from mistakes
k) make accurate mathematical diagrams, graphs and constructions on paper and on screen.

Communicating and reflecting

Pupils should be able to:

a) communicate findings effectively
b) engage in mathematical discussion of results.

3 Range and content

Number and algebra

The study of mathematics should include:

f) linear equations, formulae, expressions and identities.

Geometry and measures

The study of mathematics should include:

f) points, lines and shapes in 2D coordinate systems.

4 Curriculum opportunities

The curriculum should provide opportunities for pupils to:

a) develop confidence in an increasing range of methods and techniques

b) work on sequences of tasks that involve using the same mathematics in increasingly difficult or unfamiliar contexts, or increasingly demanding mathematics in similar contexts

f) work collaboratively as well as independently in a range of contexts.

LESSON PREPARATION

- Read the teacher notes and familiarise yourself with the other materials.
- Ensure that the activity is available to use on your teacher laptop or desktop computer.
- Ensure that the activity is available for pupils to use, e.g. via school network.
- Arrange for access to an ICT suite.
- Print off enough copies of the accompanying activity sheets.
- Decide which asteroid(s) pupils are going to use in the lesson.
- You may wish to create a certificate of achievement for pupils that perform well.

Vocabulary

Equation, function, inequality, region, greater than (>), less than (<), greater than or equal to (≥), less than or equal to (≤).

Materials required

You will need:

- Teacher laptop or desktop computer (to introduce activity)
- Data projector (to introduce activity)
- Access to an ICT suite with enough computers for pupils to work in small groups
- Printed copies of the accompanying activity sheets
    - Captain's Log Sheet
    - Mission Results Sheet

Prior knowledge and skills

Pupils should already:

- have some knowledge of drawing graphs of equations.

Health and Safety

All standard safety procedures with computers need to be in place.

Further information can be found at http://schools.becta.org.uk

LESSON DETAILS

Starter Activity

Project the starter activity onto a whiteboard.

Ask pupils in their groups to consider the graphs displayed on each slide.

Project the first slide showing the lines $x = 2$ and $y = -3$.

Explain to your pupils that you want them to work out the equation of each line.

In each case, ask your pupils to:

- list the x and y coordinates of 5 points on each line
- identify what their chosen coordinates all have in common.

Using the information provided ask them to give the equation of each line.

Project the second slide showing the lines $y = x$ and $y = x + 2$.

Repeat the process described above.

If time allows, ask your pupils to draw other lines such as $y = x + 3$, $y = x – 1$ and so on.

Ask them to comment on the lines that they have drawn.

Project the third slide showing the lines $x = -2$ and $y = x$.

On the first graph, the yellow region is defined as $x > -2$ and the blue region is defined as $x < -2$.

On the second graph, the yellow region is defined as $y < x$ and the blue region is defined as $y > x$.

In each case, ask your pupils to:

- give the equation of each line as before
- list the x and y coordinates of 5 points in the yellow region
- identify what their chosen yellow coordinates all have in common
- list the x and y coordinates of 5 points in the blue region
- identify what their chosen blue coordinates all have in common.

Using the information provided ask them to define each region.

Annotate each graph on the whiteboard to record their findings.

Lead into the main activity (see below).

Main Activity

The aim of this activity is to destroy the asteroids blocking the Orbital Highway.

This can be achieved by correctly placing sonic charges on each asteroid's surface.

Once placed, the sonic charges can be detonated.

Upon detonation, a certain amount of valuable asteroid ore will be left behind.

The amount of asteroid ore that can be collected will depend on:
- the types of charges used
- the number of charges placed correctly.

Pupils will receive 'special recognition' if they can:
- find a way to collect the maximum amount of ore for each asteroid.

This activity is based around an open problem with a complexity of potential interpretations.

Opportunities for discussion and group presentations have been incorporated into the activity.

Pupils should be arranged in small groups at a computer.

With mixed ability classes, try to ensure that each group has an appropriate mix of pupils.

This will help to create appropriate conditions for peer support.

Each group should be given:
- a copy of the 'Activity 3 - Captain's Log' sheet
- a copy of the 'Activity 3 - Mission Results' sheet.

Introduce the activity by projecting it onto a whiteboard.

Set the scene using the introductory narrative and the Captain's Log sheet to help.

Note that there are a number of different asteroids to choose from:
- Andromeda 364
- Betelgeuse 721
- Capricorn 918.

Andromeda 364
- based on simple linear equations
- hazard rating - low
- maximum ore value - low (5000 Credits).

Betelgeuse 721
- based on more complex linear equations and simple quadratic equations
- hazard rating - medium
- maximum ore value - medium (7500 Credits).

Capricorn 918
- based on inequalities and regions
- hazard rating - high
- maximum ore value - high (10000 Credits).

Specify clearly which asteroid(s) you want your pupils to attempt.

Refer pupils to the 'Getting Started' section on the Captain's Log sheet.

This fleshes out the narrative a little more and provides an introduction to the activity interface.

Allow time for pupils to experiment with the activity as directed.

Once ready, refer pupils to the 'Discussion Time' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow time for pupils to discuss their thoughts and define their strategies.

Try to circulate between groups listening to discussion and asking questions as required.

Encourage pupils to pursue their strategies and to develop the mathematics involved.

Take care, however, not to overly direct the pupils.

Once ready, refer pupils to the 'Recording Your Results' section on the Captain's Log sheet.

Pupils should drag and drop their chosen charges onto the asteroid's surface.

Once the set number of charges has been placed, the 'Detonate' button becomes active.

Once clicked, the sonic charges will explode.

Pupils will then receive feedback relating to:

- the number of their charges that have detonated correctly
- whether the asteroid was destroyed or not
- the income they have received from the asteroid ore.

Ensure that pupils record their results in the table on the Mission Results sheet.

Pupils are asked to calculate what % of the maximum ore amount they have collected each time.

Pupils should repeat the process until the relevant sections of the table are complete.

Pupils can then determine if they are deserving of the 'special recognition' award.

Ask pupils to review their results and consider the questions listed.

Allow time for pupils to discuss their results and record their responses in the space provided.

Once ready, refer pupils to the 'Finishing Off' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow some time for pupils to discuss their thoughts and reflect on their performance.

If time allows, ask pupils to repeat the process, refining their original strategies.

Lead into the plenary activity (see below).

Plenary

Draw the class together and ask pupils to reflect on the activity.

Ask each group to report back on their progress, specifically:

- whether they were able to destroy their chosen asteroid(s)
- the average income they received from the asteroid ore.

Ask selected groups to describe and evaluate the strategies they used.

In particular, ask them to identify what they would do differently next time.

If time allows, ask pupils some follow-up questions such as:

- What was the key to success in this activity?
- How would it be possible to gain the maximum amount of ore from each asteroid?

Finally, ask the class to consider the maths that they have used during the activity.

Ask the class to identify real-life contexts where people may use similar maths.

Homework Suggestions

Ask pupils to complete their Captain's Log reflecting on their results and evaluating their performance during the activity.

Additionally, pupils could be invited to complete the accompanying homework task sheet. The sheet is divided into different sections relating to the equations and inequalities used in the main activity and gives further practice in the use of linear equations, quadratic curves and regions.

TECHNICAL SUPPORT

This activity makes use of Flash and Adobe PDF files. To access all the resources that are provided, you will need the minimum machine and software specifications as listed below.

Adobe Flash Player (previously know as Macromedia Flash Player) is required to launch the activity. The latest version of Flash and guidance on how to use it can be downloaded from:

http://www.adobe.com/shockwave/download/download.cgi?P1_Prod_Version=ShockwaveFlash

Adobe Reader or Distiller is required to view these notes. The latest version of Reader and guidance on how to use it can be downloaded from:

http://www.adobe.com/products/reader/

Minimum Machine and Software Specifications

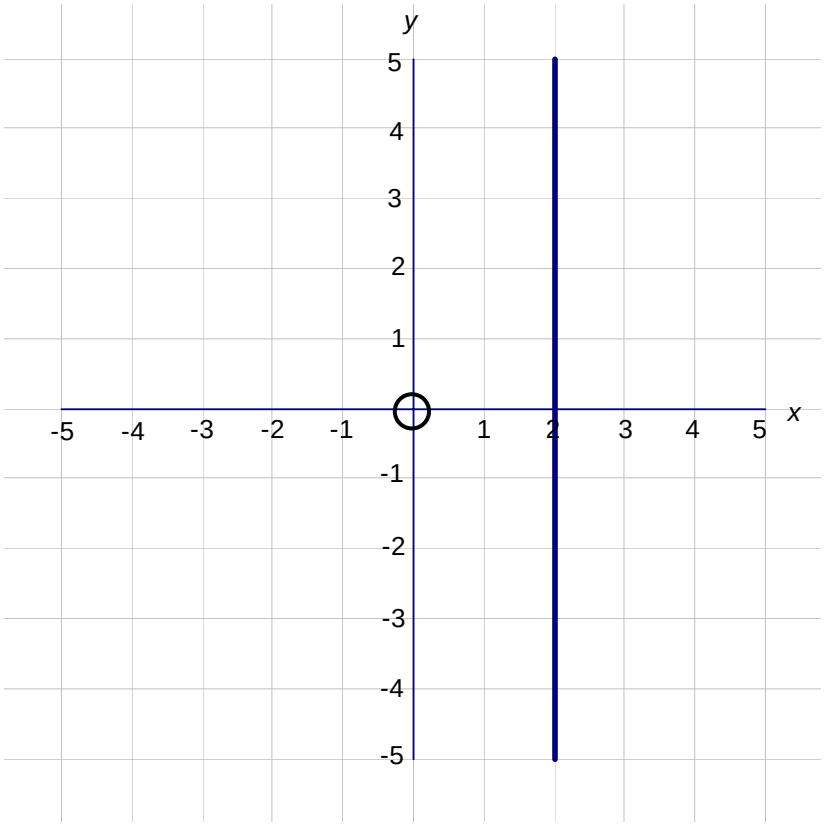
PC

P3 800MHz
128MB RAM
Windows 2000
Screen resolution 1024 x 768
Microsoft Internet Explorer 5.5, Firefox 1, Netscape 7 or Opera 7
Macromedia Flash Player 7
Adobe Reader 7

Mac

G3 500MHz
128MB RAM
OS X 10.2
Screen resolution: 1024 x 768
Safari 1, Firefox 1, Netscape 7, or Opera 6.2
Macromedia Flash Player 7
Adobe Reader 7

Activity 3 Starter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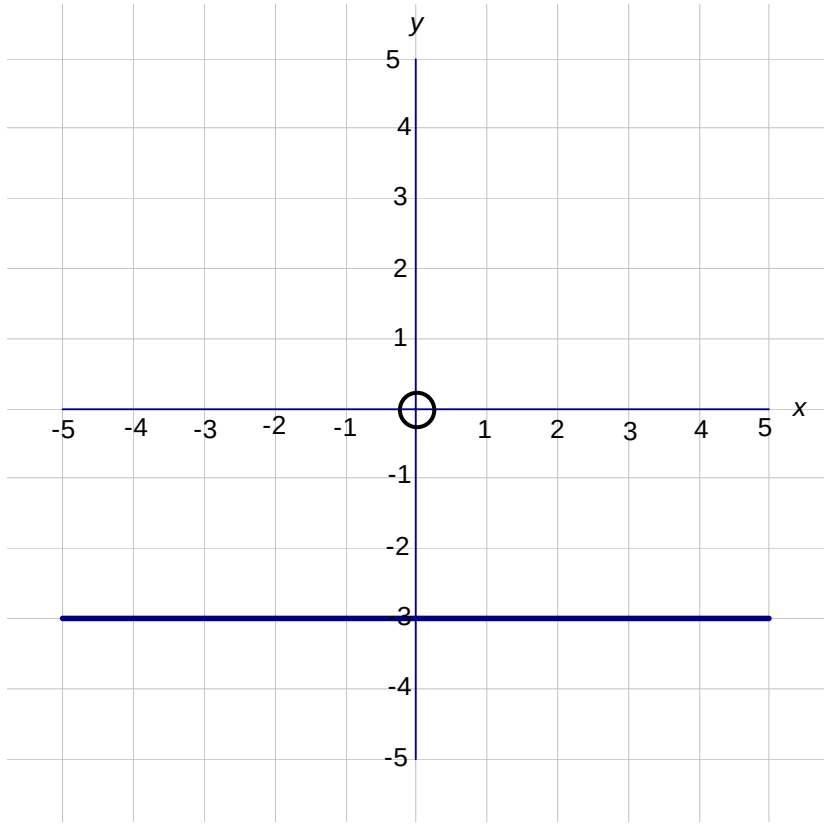
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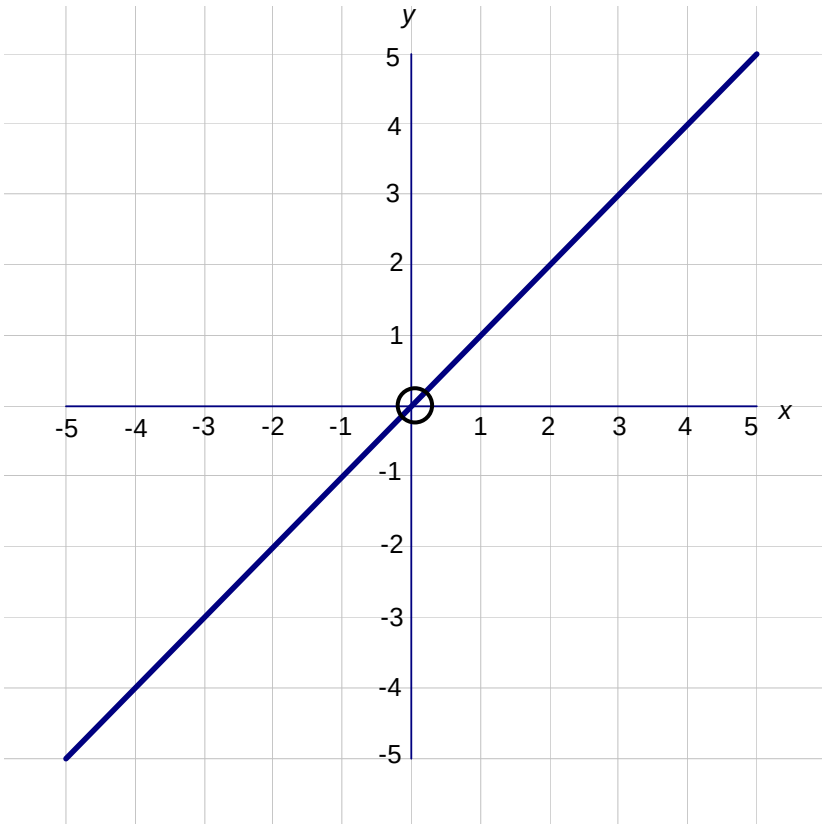
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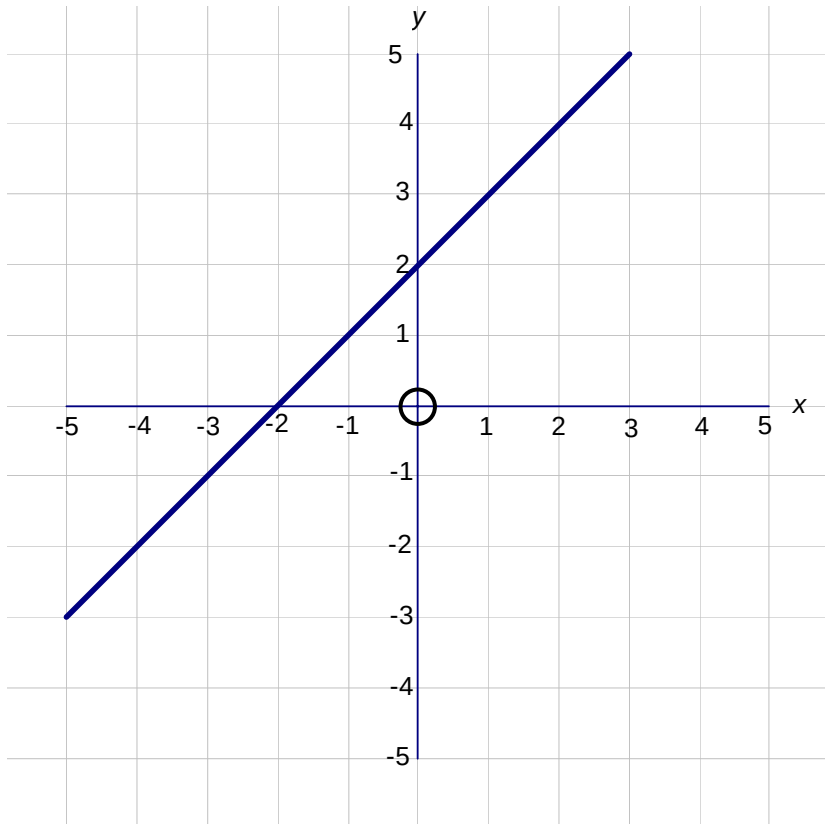
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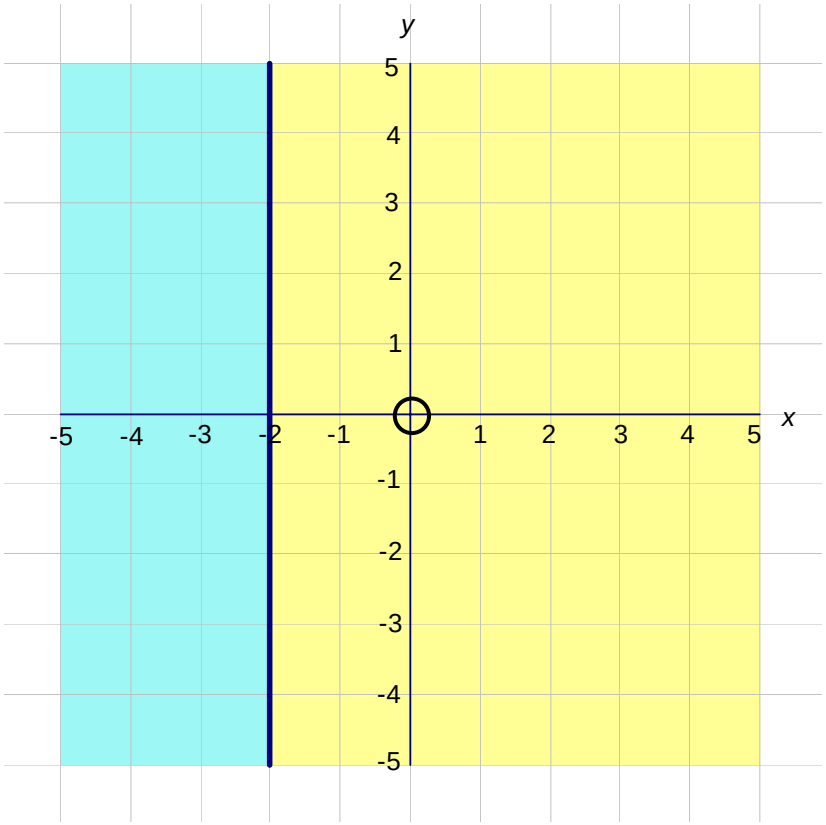
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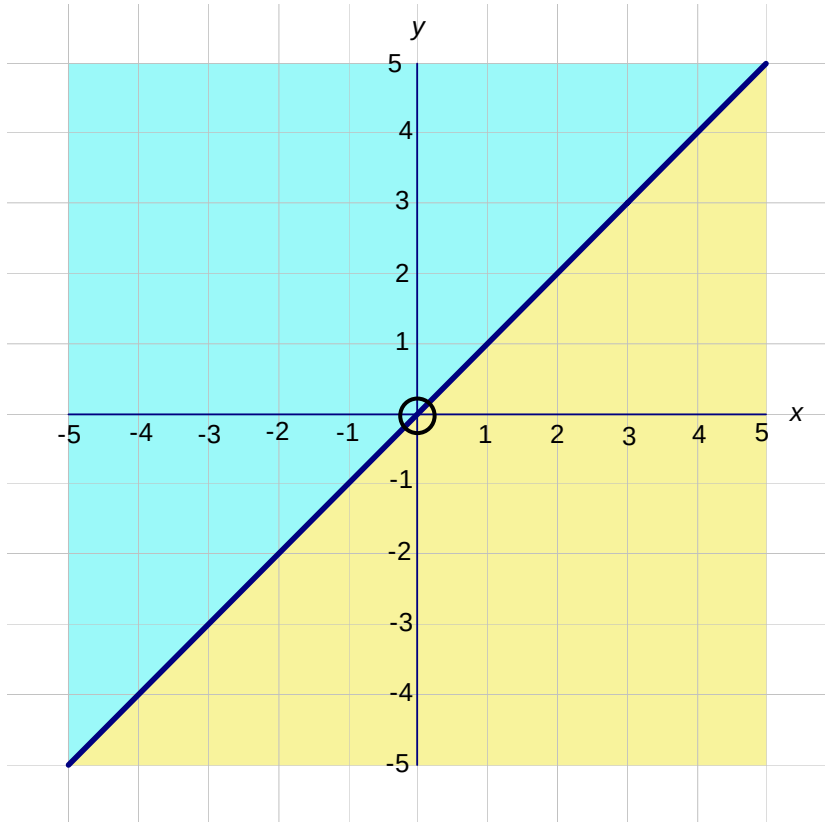
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EXPLORERS ACTIVITY 3 - CAPTAIN'S LOG

Your aim in this mission is to destroy some rogue asteroids blocking the Orbital Highway.

You will receive special recognition if you can:
- collect the maximum amount of ore from each asteroid that you destroy.

Getting Started
Click on the mining ship docked at Explorers Space Station to start (see screen shot A below).

Within your group, discuss the information that appears on screen (see screen shot B below).

Experiment with the activity—in particular, observe what happens if you:
- click on one of the four different types of sonic charges
- drag and drop a sonic charge over the asteroid grid
- click on the 'Clear Charges' button in the bottom corner.

What do you imagine each section of the screen is meant to show?

A)

B)

The 'Detonate' button will initially be inactive.

It will only become active once the set number of sonic charges have been placed.

Once clicked, your sonic charges will explode.

The outcome you get will depend on:
- the combination of sonic charges you have used
- how many of your charges were correctly placed.

Discussion Time
Take some time to discuss this problem with the rest of your group.
- How are you going to approach this problem?
- What information will you need to use?
- What overall strategy are you going to employ?

Write your comments in this space.

Recording Your Results
Drag and drop your chosen charges onto the asteroid's surface.

Once the set number of charges has been placed, count how many of each type you have used.

Record your figures in the results table on the separate sheet.

Once ready, click the 'Detonate' button to proceed.

Use the feedback provided to determine how successful you have been.

Record your outcomes after each attempt in the results table on the separate sheet.

Repeat the process for each asteroid until the table is complete.

Within your group, discuss your results:
- How would you describe your results?
- Can you see any patterns in your results?
- Is it possible to explain your results?

Describe and attempt to explain your results in this space.

Finishing Off
Now, within your group, discuss the following:
- How satisfied were you with your performance?
- Were the strategies you employed successful?
- How would you do things differently next time?

Write your comments in this space.

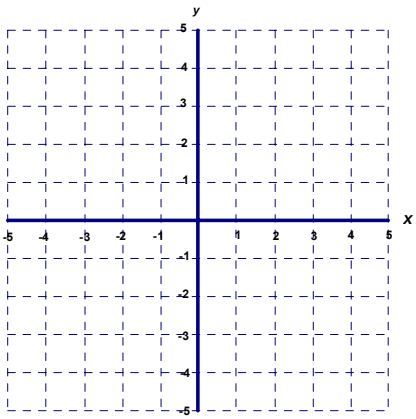
EXPLORERS MINING ENTERPRISES — RESULTS

There's no time to waste… those commuters on the Orbital Highway aren't happy.
We've got a 67 light-year tailback to clear all the way back to the moons of Epsilon Prime.
Record your results every time you detonate your charges in the table shown below.
Keep your results safe at the end… you'll need them again soon.

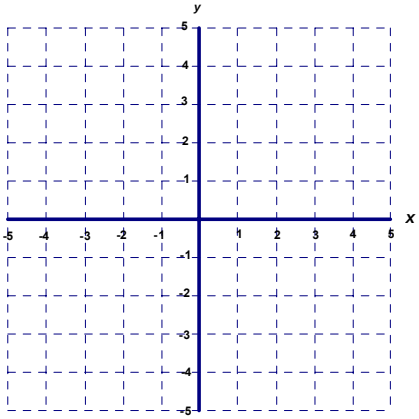
	Sonic Charges Used				Detonation	Asteroid Ore Collected		
	Disrupter	**Disintegrator**	**Blaster**	**Vaporiser**	**Charges Detonated**	**Value Of Collected Ore (Credits)**	**Maximum Ore Yield (Credits)**	**% Of Maximum Ore Collected**
Andromeda 364								
Attempt 1					__ out of 10		5000	
Attempt 2					__ out of 10		5000	
Attempt 3					__ out of 10		5000	
Betelgeuse 721								
Attempt 1					__ out of 15		7500	
Attempt 2					__ out of 15		7500	
Attempt 3					__ out of 15		7500	
Capricorn 918								
Attempt 1					__ out of 20		10000	
Attempt 2					__ out of 20		10000	
Attempt 3					__ out of 20		10000	

Andromeda 364

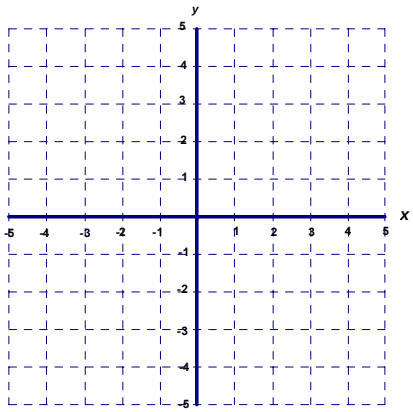
1 $x = 4$



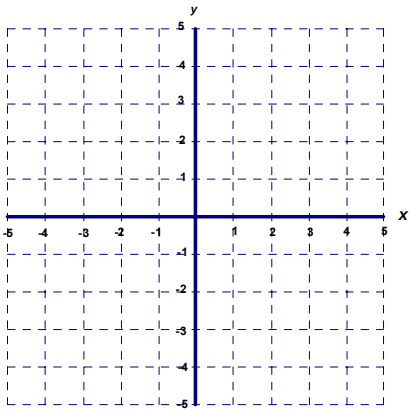
2 $y = 2$



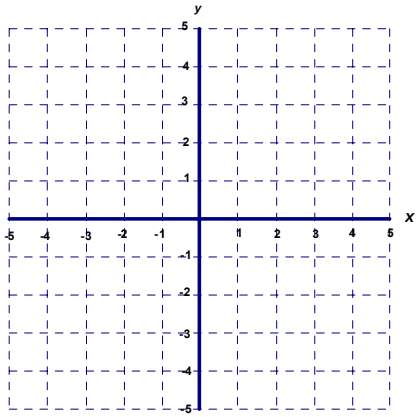
3 $x = -1$



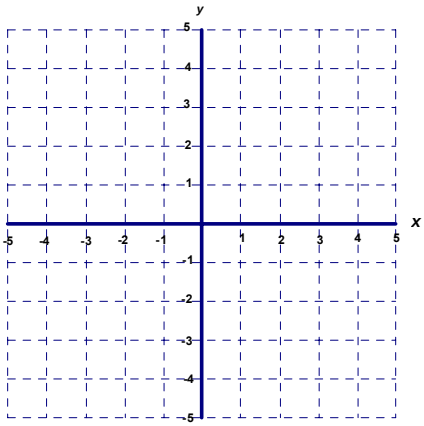
4 $y = -5$



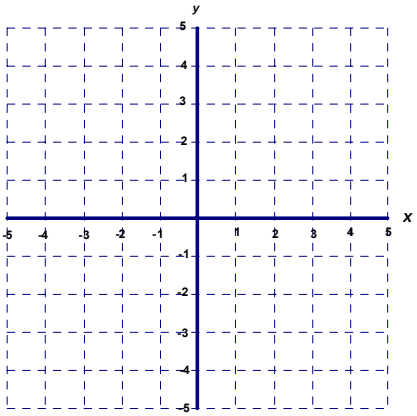
5 $x = 0$



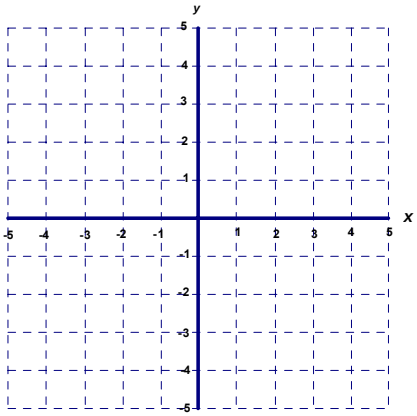
6 $x = 3$



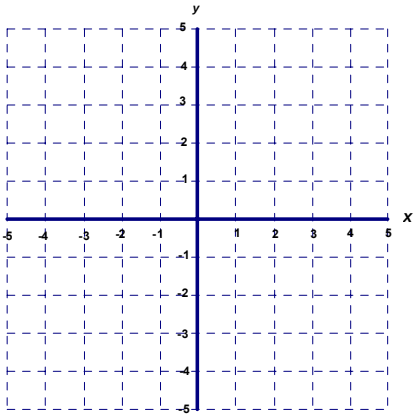
7 $y = -2$



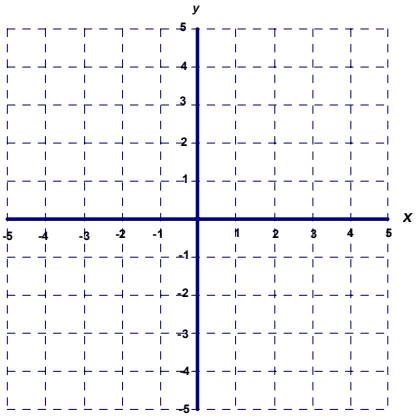
8 $y = 0$



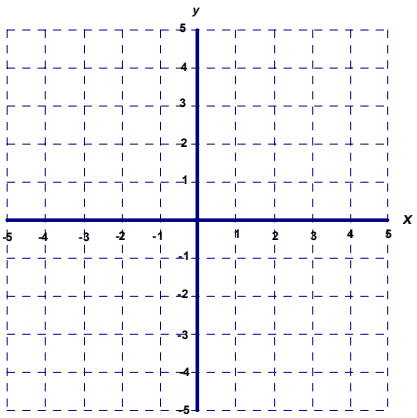
9 $y = x$



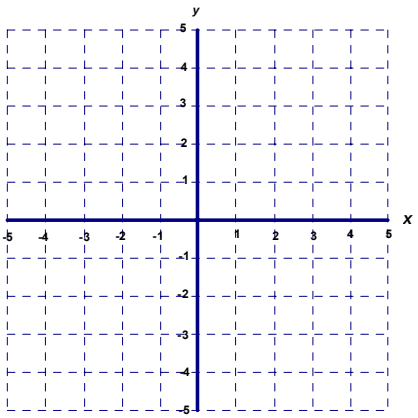
10 $y = x + 2$



11 $y = -x$

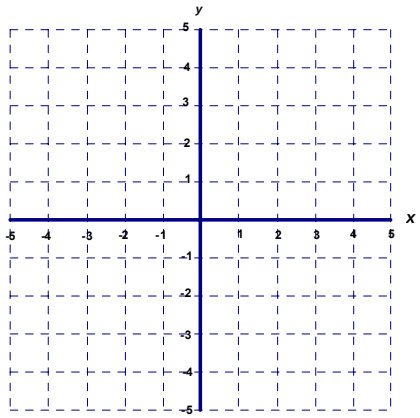


12 $y = x - 2$

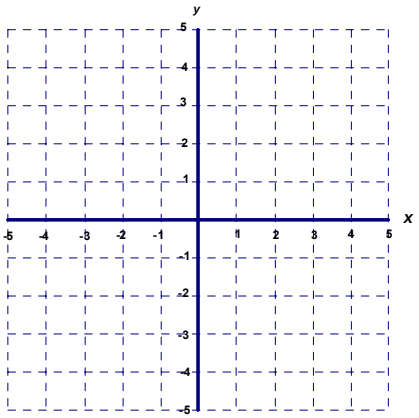


Betelgeuse 721

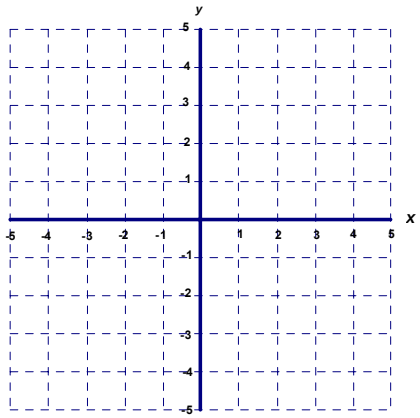
1 $y = x - 3$



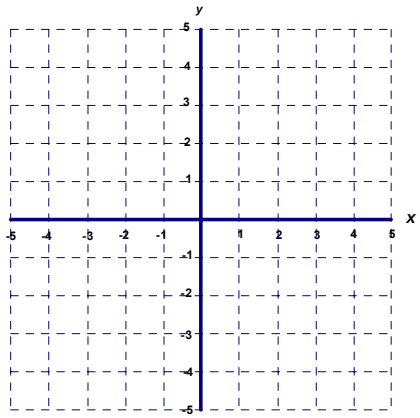
2 $y = x + 4$



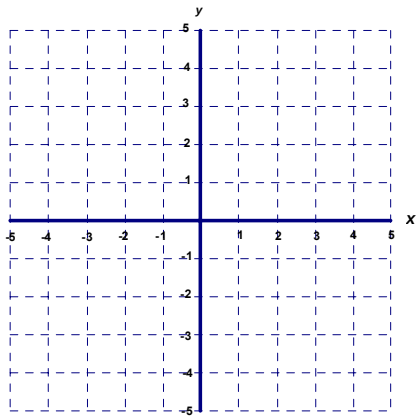
3 $y = 2x - 1$



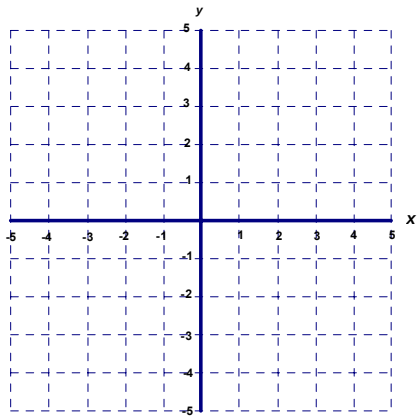
4 $y = 2(x - 1)$



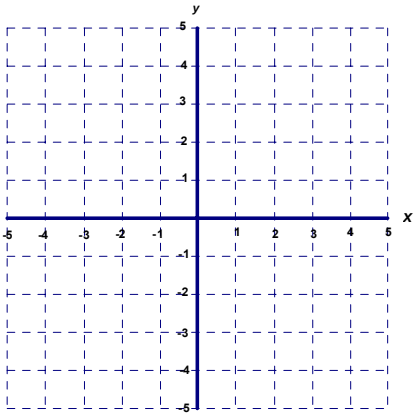
5 $y = -x + 1$



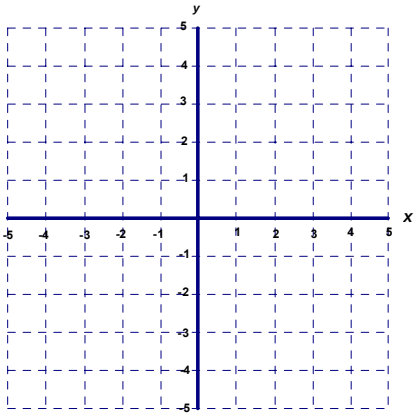
6 $y = -(x + 1)$



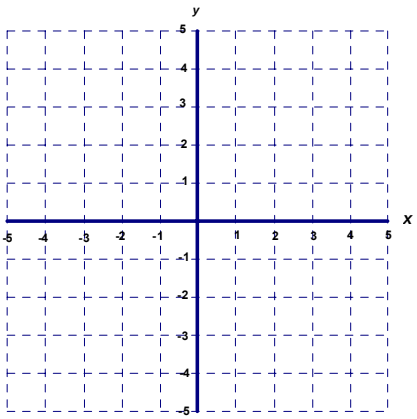
7 $y = -2x$



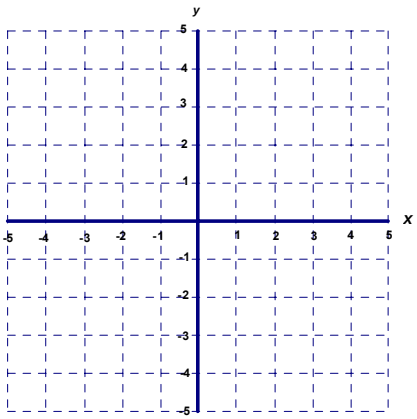
8 $y = 2(x - 2)$



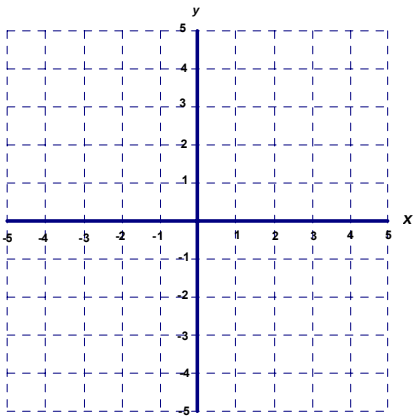
9 $x + y = 2$



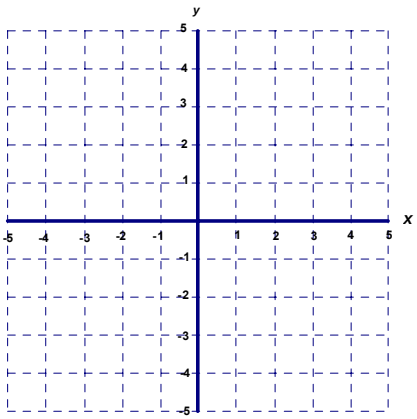
10 $x + y = -3$



11 $x + y = 1$

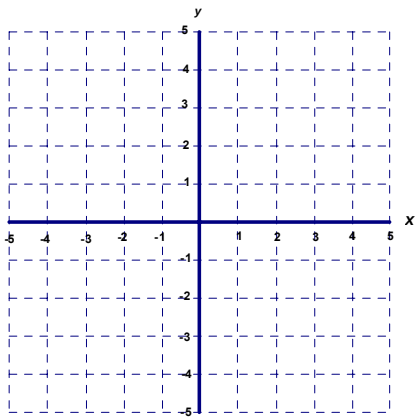


12 $-x + y = 2$

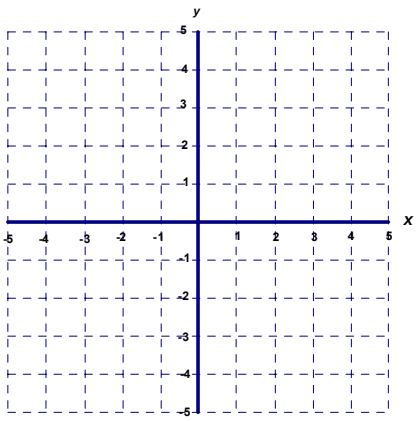


Capricorn 918

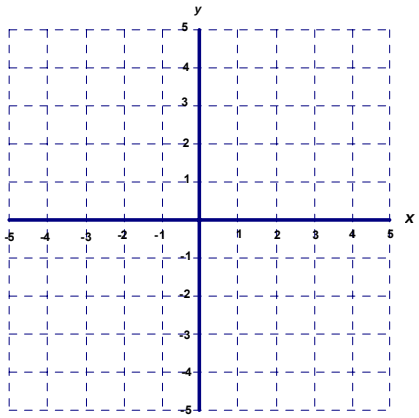
1 $y < \frac{1}{2}x$



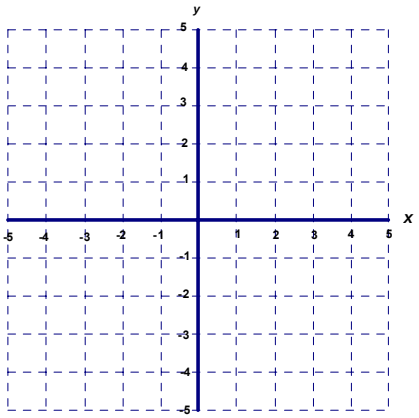
2 $y > 3x - 2$



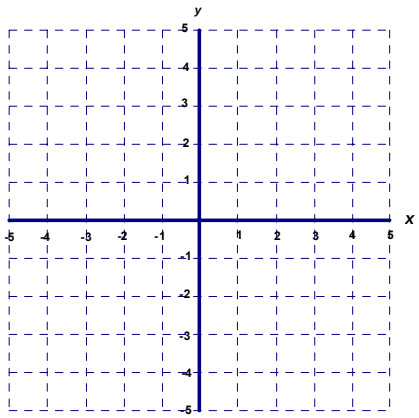
3 $y \leq -x + 2$



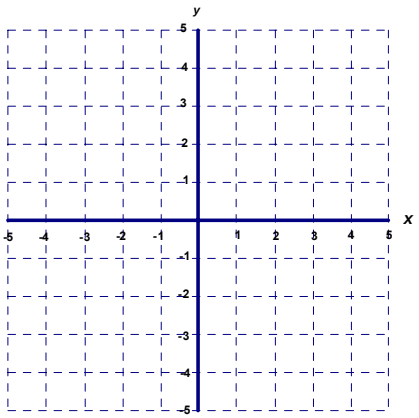
4 $y \geq 3 - 2x$



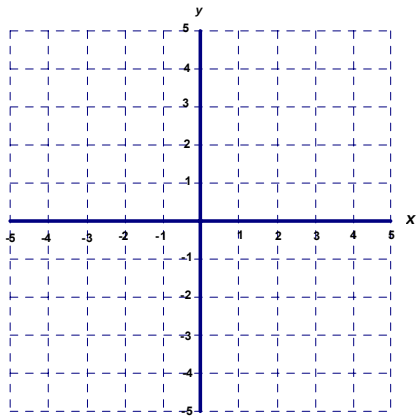
5 $y > \frac{x}{2} + 3$



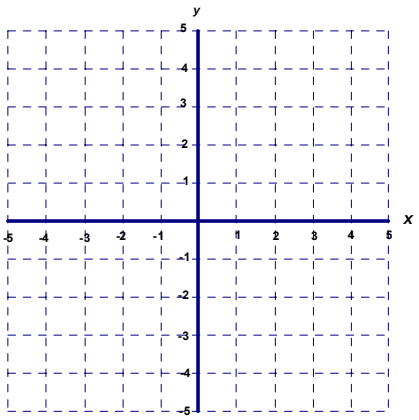
6 $y \leq x^2 + 2$



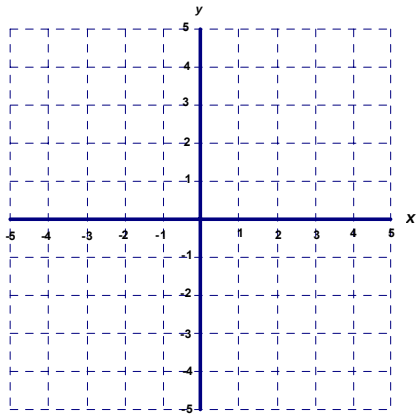
7 $x + y > 2$



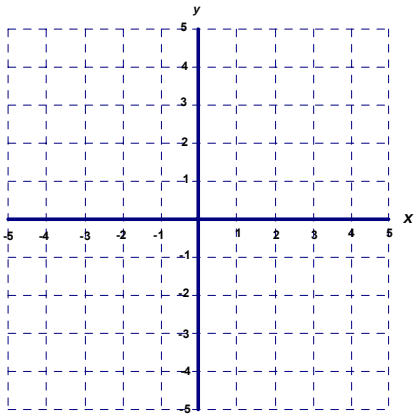
8 $x + y < -4$



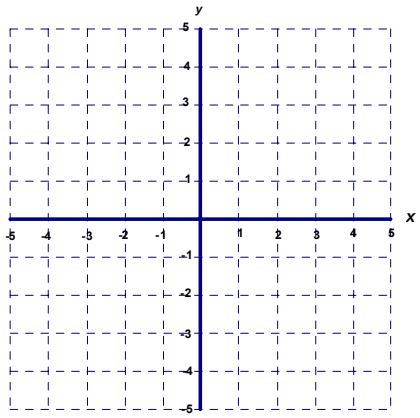
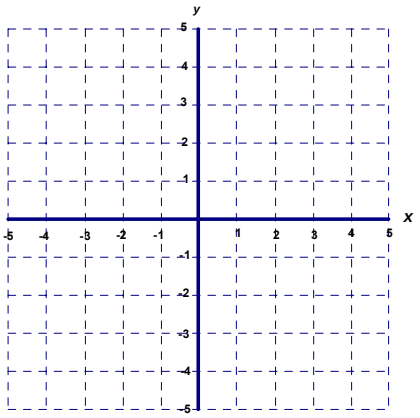
9 $x + y < -1$ and $y > x^2 - 2$



10 $y - x \leq 4$ and $y > x^2$



11 $y > 2x - 4$ *and* $y < -x^2$



12 $y > x^2 + 1$ *and* $x + y \leq 2$