

Lens Ray Diagrams

Mark Scheme



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1. Lenses have many uses in modern life from phone cameras to magnifying glasses. Answer the following questions. Circle the letter of the correct answer for each.

a) A student is drawing a ray diagram to determine the image formed by a converging lens. They draw a ray parallel to the principal axis. After passing through the lens, this ray will:

B – is the only correct answer.	1 mark
	Total: 1 mark

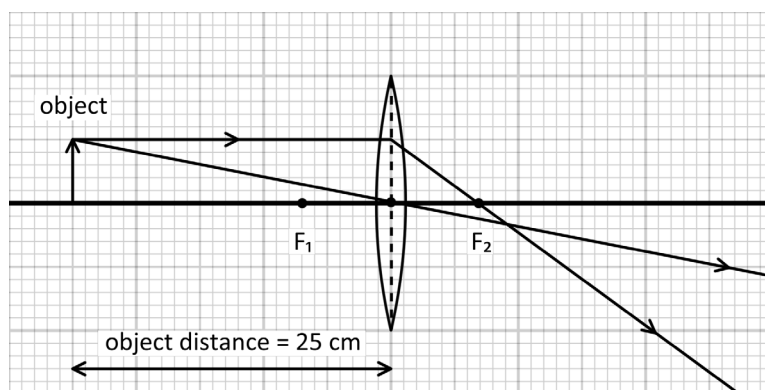
b) An object is placed between the focal point (F) and a converging lens. When a ray diagram is drawn for this situation, the resulting image will be:

C – is the only correct answer.	1 mark
	Total: 1 mark

c) A student sets up a diverging lens. When drawing a ray diagram, they draw a ray aimed directly at the focal point on the other side of the lens (as if it would pass through it if the lens wasn't there). After passing through the diverging lens, this ray will:

C – is the only correct answer.	1 mark
	Total: 1 mark

d) The figure below shows the ray diagram for convex lens.



Determine the focal length of the convex lens from the figure above.
Each little square represents 1 cm on real life.

There are 7 little squares from the centre of the lens to the focal point F2.	1 mark
Therefore the <u>focal length</u> is 7cm.	
	Total: 1 mark

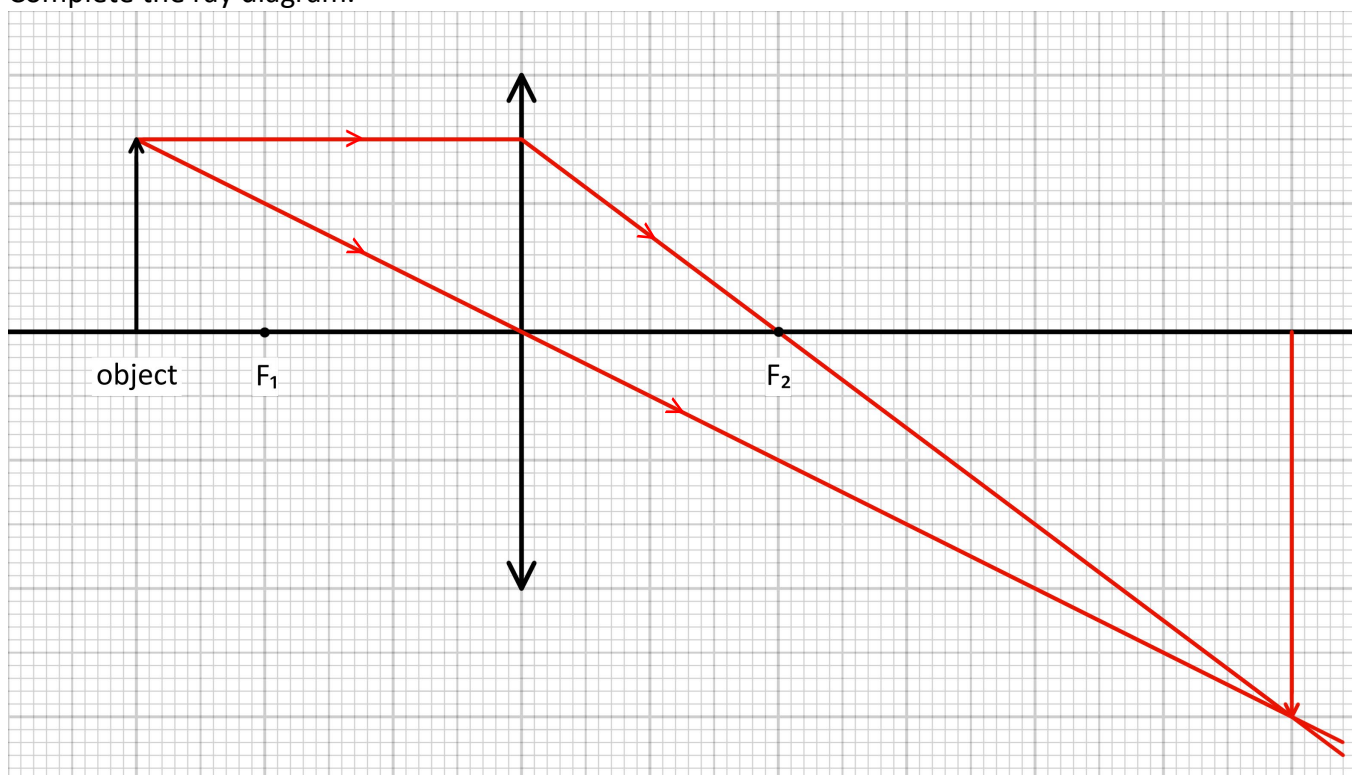
(Total for Question 1 is 4 marks)

2. The figure below shows part of a ray diagram for a lens.

a) State the type of lens shown in the figure below.

Convex or converging lens	1 mark
	Total: 1 mark

b) Complete the ray diagram.



Horizontal ray correctly drawn passing through the second focal point.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line with an arrowhead drawn from the x axis to where the two rays meet.	1 mark
Direction arrows on each line.	1 mark
	Total: 4 marks

c) Describe the image formed by the lens.

A description to include the following:	
The image is <u>real</u>	1 mark
It is <u>inverted</u>	1 mark
It is <u>enlarged</u> .	1 mark
	Total: 3 marks

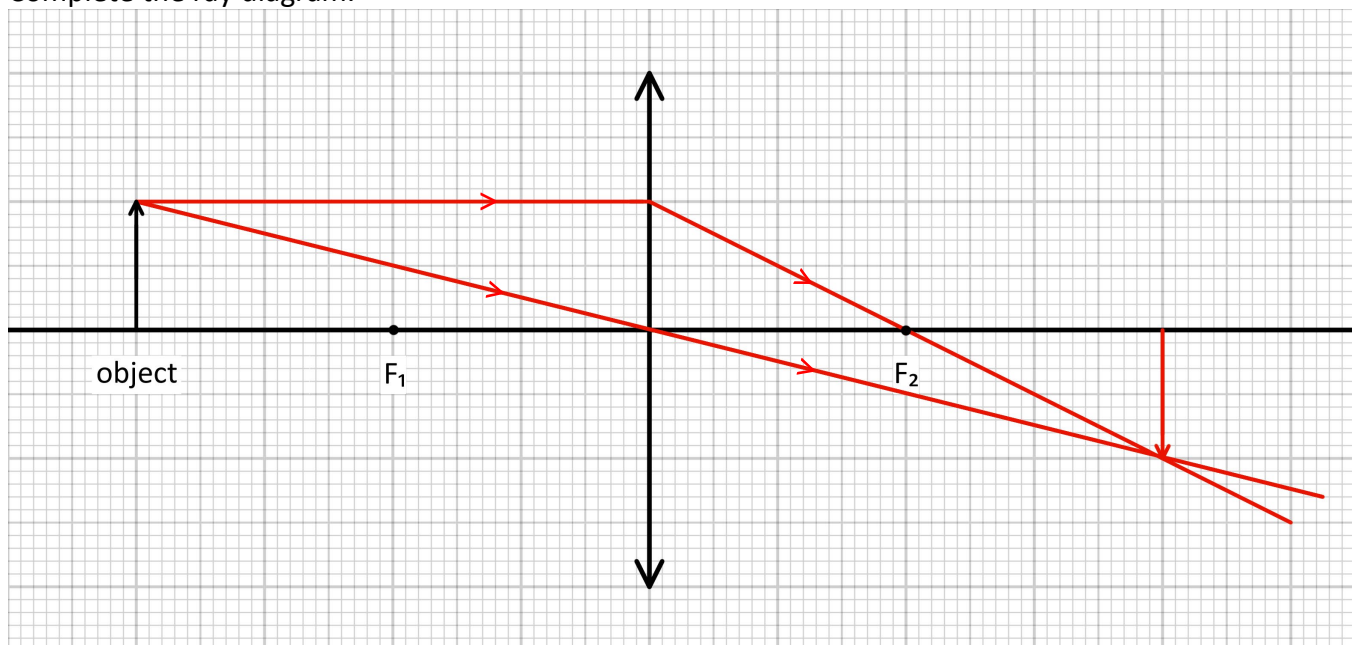
(Total for Question 2 is 7 marks)

3. The figure below shows part of a ray diagram for a lens.

a) State the type of lens shown in the figure below.

Convex or converging lens	1 mark
	Total: 1 mark

b) Complete the ray diagram.



Horizontal ray correctly drawn passing through the second focal point.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line with an arrowhead drawn from the x axis to where the two rays meet.	1 mark
Direction arrows on each line.	1 mark
	Total: 4 marks

c) Describe the image formed by the lens.

A description to include the following:	
The image is <u>real</u>	1 mark
It is <u>inverted</u>	1 mark
It is <u>enlarged</u> .	1 mark
	Total: 3 marks

They find that the sharpest image is formed when the screen is placed 20 cm away from the lens.

d) What is the focal length of this converging lens? State your answer in metres.

0.20 m	1 mark
	Total: 1 mark

e) Calculate the power of this lens. Include the correct unit in your answer.

Power = $1 \div \text{focal length}$	
Power = $1 \div 0.20$	1 mark
Power = 5 D or 5 dioptries	1 mark
	Total: 2 marks

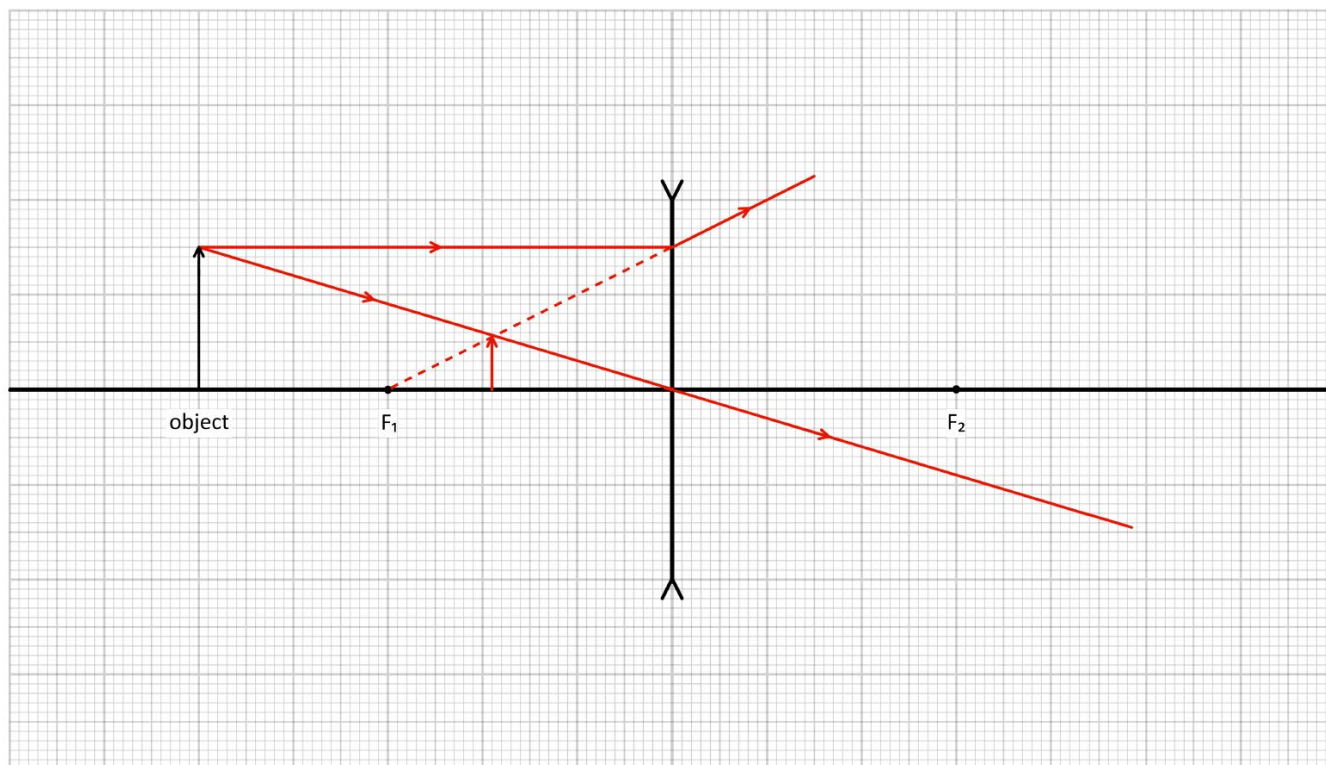
(Total for Question 3 is 11 marks)

4. The figure below shows part of a ray diagram for a lens.

a) State the type of lens shown in the figure below.

Concave or diverging lens	1 mark
	Total: 1 mark

b) Complete the ray diagram.



Horizontal ray correctly drawn being refracted away from the lens.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line drawn from the x axis to where the imaginary ray meets the real ray.	1 mark
Direction arrows on each line.	1 mark
	Total: 4 marks

c) Describe the image formed by the lens.

A description to include the following:	
The image is <u>virtual</u>	1 mark
It is <u>upright</u>	1 mark
It is <u>reduced</u> .	1 mark
	Total: 3 marks

d) What is the focal length of this concave lens?

- 0.15 m	1 mark
	Total: 1 mark

e) Calculate the power of this concave lens. Include the correct unit and sign in your answer.

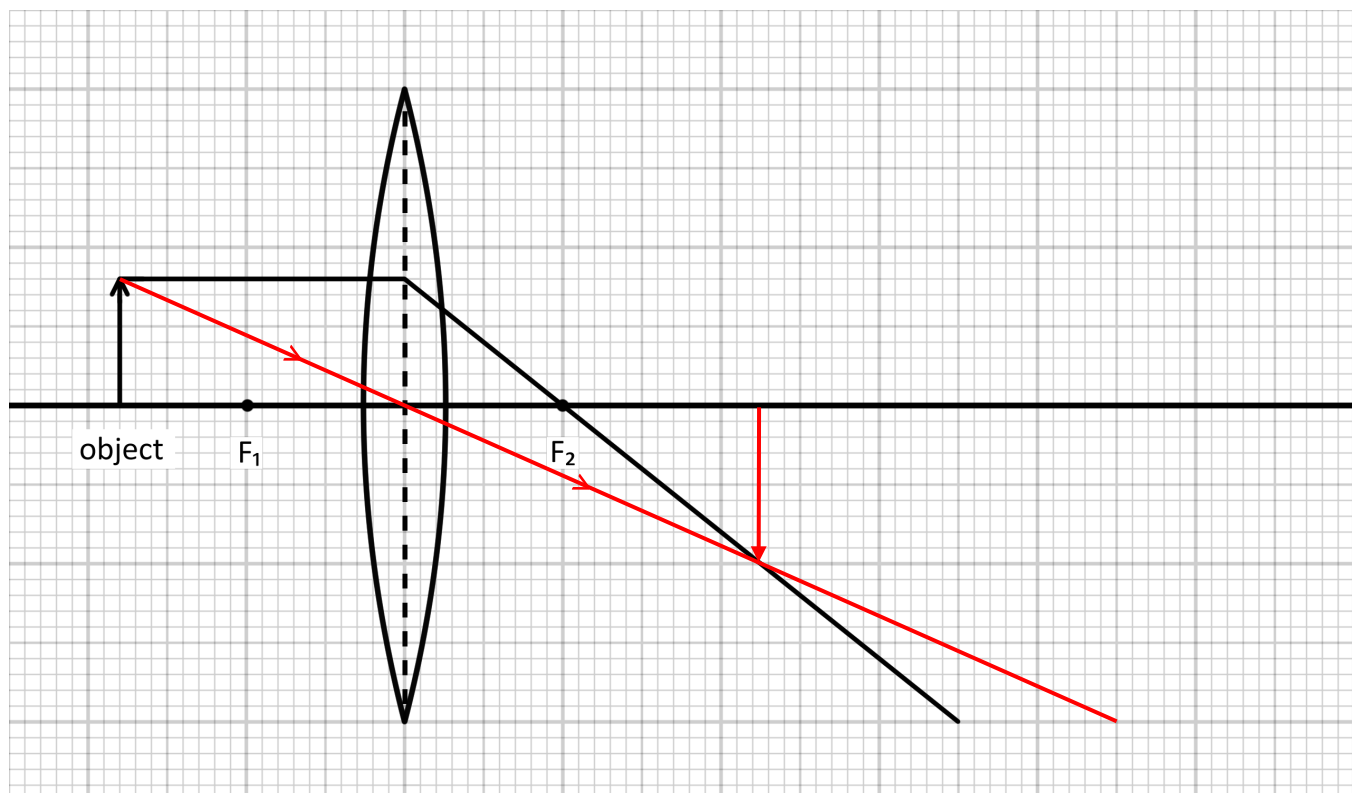
Power = $1 \div \text{focal length}$	
Power = $1 \div (-0.15)$	1 mark
Power = - 6.67 D or - 6.67 dioptries	1 mark
	Total: 2 marks

f) Explain why the power of a concave lens is **negative**.

An explanation to include the following:	
Concave lens diverges light / has a virtual focal point.	1 mark
Negative sign convention for focal length / Power is the reciprocal of focal length.	1 mark
	Total: 2 marks

The student used another lens in a separate investigation. The figure below shows the ray diagram for the new lens.

g) Complete the ray diagram for the lens below.



Ray drawn passing straight through the optical centre of the lens.	1 mark
Line drawn from the x axis to where the imaginary ray meets the real ray.	1 mark
Direction arrows on each line.	1 mark
	Total: 3 marks

h) Describe the image formed by this new lens.

A description to include the following:	
The image is <u>real</u>	1 mark
It is <u>inverted</u>	1 mark
It is <u>enlarged</u> .	1 mark
	Total: 3 marks

(Total for Question 4 is 18 marks)

5. A student conducted an experiment to demonstrate refraction using a lens.

a) Describe the process of refraction.

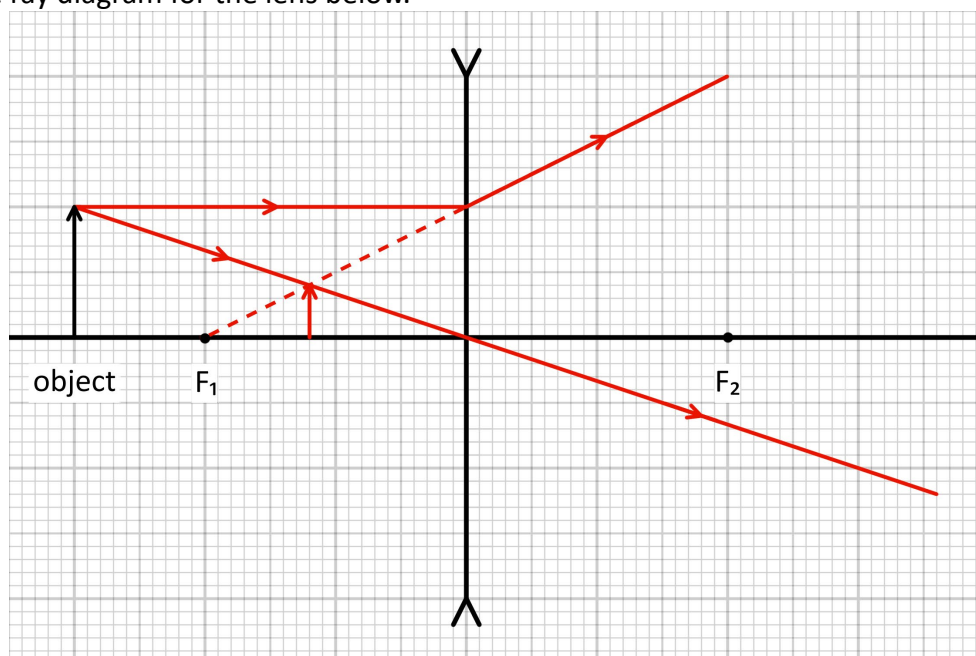
A description to include the following:	
Refraction is the <u>change in direction</u>	1 mark
and <u>speed</u> of a wave as it enters or leaves a material with a	1 mark
Different <u>refractive index</u> .	1 mark
	Total: 3 marks

b) State the law of refraction.

The angle of incidence is greater than the angle of refraction.	2 marks
Or $\theta_i > \theta_r$	
	Total: 2 marks

The figure below shows the uncompleted ray diagram for the lens the student used.

c) Complete the ray diagram for the lens below.



Horizontal ray correctly drawn being refracted away from the lens.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Arrow drawn from the x axis to where the imaginary ray meets the real ray.	1 mark
	Total: 3 marks

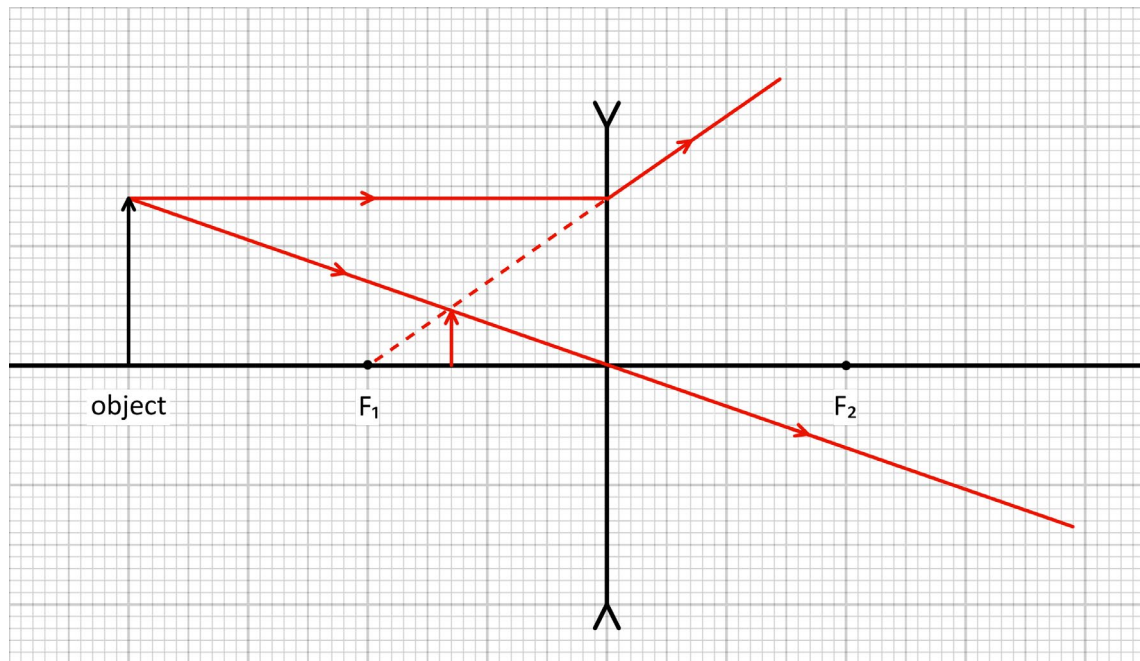
d) Describe the image formed by this lens.

A description to include the following:	
The image is <u>virtual</u>	1 mark
It is <u>upright</u>	1 mark
It is <u>reduced</u> .	1 mark
	Total: 3 marks

(Total for Question 5 is 11 marks)

6. A teacher has drawn an incomplete ray diagram for a concave lens.

a) Complete the ray diagram below.



Horizontal ray correctly drawn being refracted away from the lens.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line drawn from the x axis to where the imaginary ray meets the real ray.	1 mark
Direction arrows on each line.	1 mark
Total: 4 marks	

b) Describe the image formed by this lens.

A description to include the following:	
The image is <u>virtual</u>	1 mark
It is <u>upright</u>	1 mark
It is <u>reduced</u> .	1 mark
Total: 3 marks	

Another student shines a parallel beam of red light through a different concave lens.

After passing through the lens, the light rays diverge. If these diverging rays are traced back, they appear to originate from a point 25 cm in front of the lens.

c) Calculate the power of this concave lens. Show your working and give your answer to two decimal places with the correct unit and sign.

Focal length = -0.25 m	1 mark
Power = $1 \div \text{focal length}$	
Power = $1 \div (-0.25)$	1 mark
Power = -4.00 D or -4.00 dioptres	1 mark
Total: 3 marks	

- d) If the student were to use a concave lens with a power of -8.0 D , would the light rays diverge more or less compared to the lens in part (c)? Explain your answer.

A explanation to include the following:	
The light rays would diverge <u>more</u> .	1 mark
Then any <u>one</u> of the following:	
A concave lens with a power of -8.0 D is a stronger diverging lens than the one in part (c) which has a power of -4.00 D .	1 mark
The power of a lens is inversely proportional to its focal length ($P = 1 \div f$).	1 mark
Therefore, a higher magnitude of negative power corresponds to a shorter focal.	1 mark
	Total: 2 marks

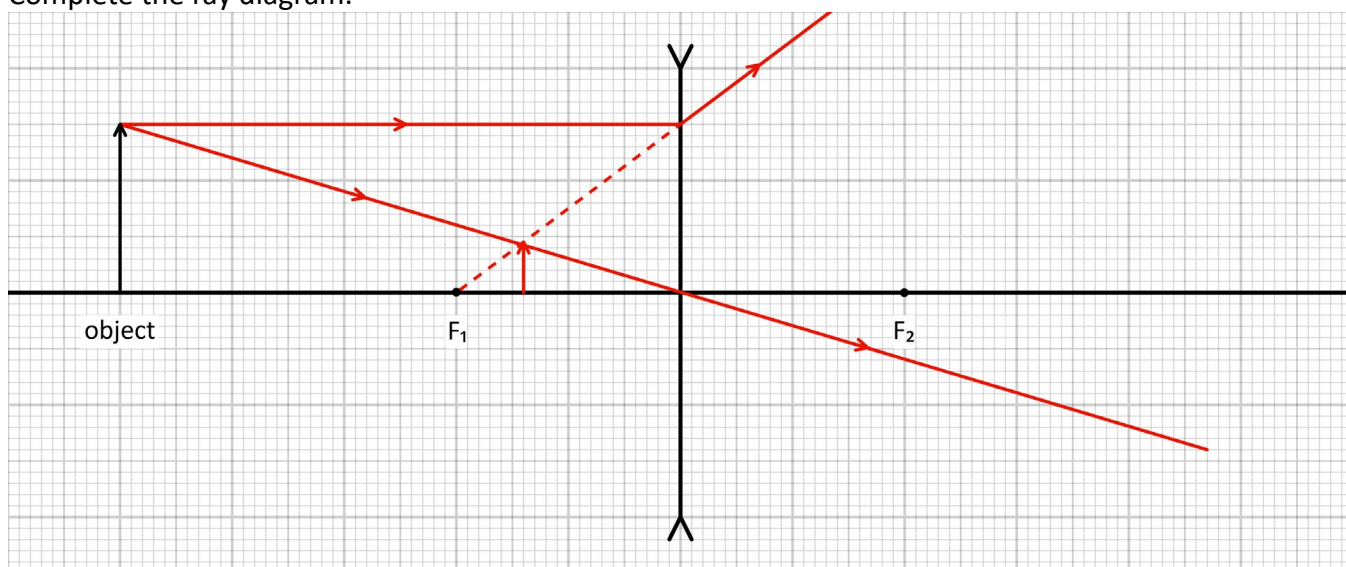
(Total for Question 6 is 11 marks)

7. A student was doing an experiment investing the refractive index of a lens.

- a) What is a refractive index?

It is a measure of how much a wave is refracted as it moves through a material.	1 mark
Accept differently worded versions of this answer that convey the same meaning.	
	Total: 1 mark

- b) Complete the ray diagram.



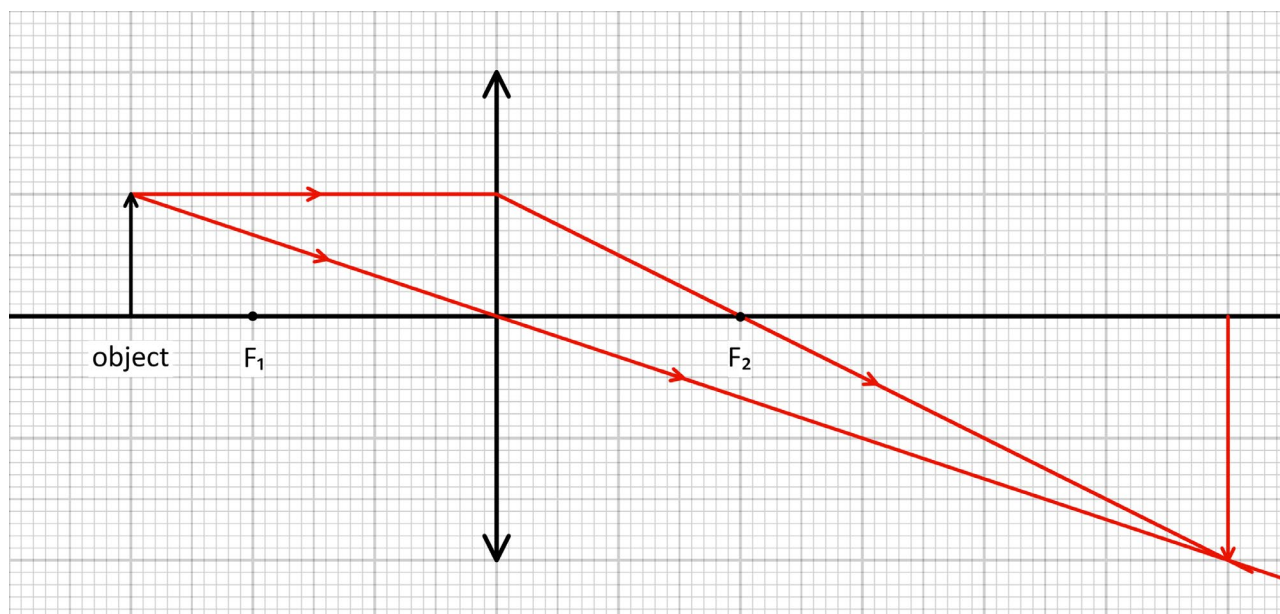
Horizontal ray correctly drawn being refracted away from the lens.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line drawn from the x axis to where the imaginary ray meets the real ray.	1 mark
Direction arrows on each line.	1 mark
	Total: 4 marks

- c) Describe the image formed by this lens.

A description to include the following:	
The image is <u>virtual</u>	1 mark
It is <u>upright</u>	1 mark
It is <u>reduced</u> .	1 mark
	Total: 3 marks

(Total for Question 7 is 8 marks)

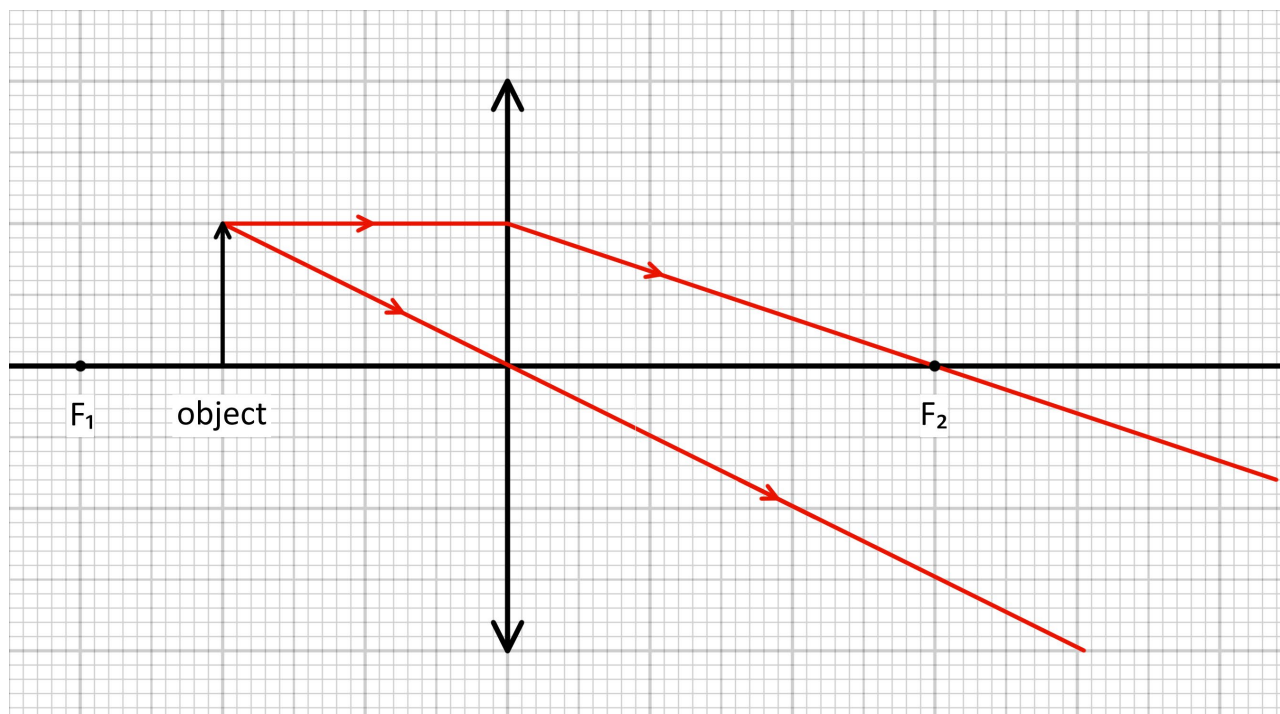
8. Complete the ray diagram for the lens in the figure below.



Horizontal ray correctly drawn passing through the second focal point.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line with an arrowhead drawn from the x axis to where the two rays meet.	1 mark
Direction arrows on each line.	1 mark
Total: 4 marks	

(Total for Question 8 is 4 marks)

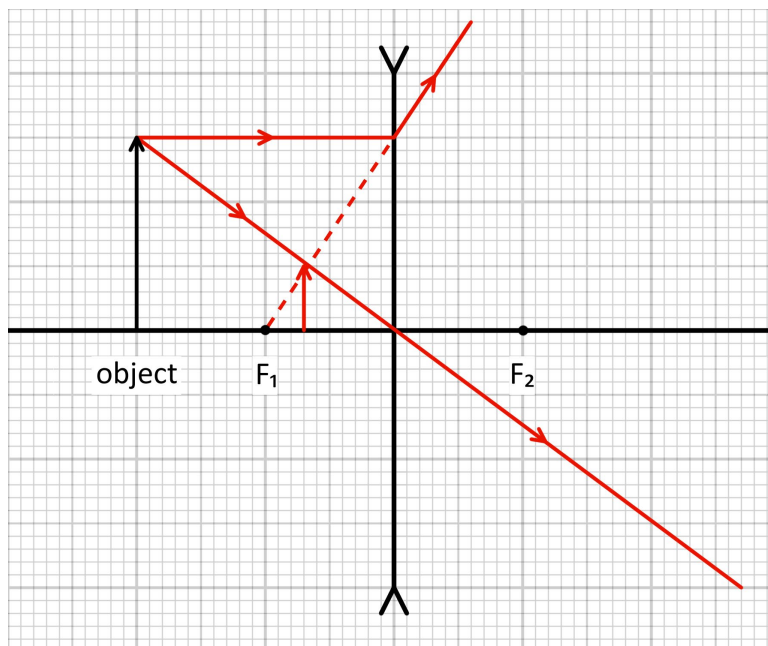
9. Complete the ray diagram for the lens in the figure below.



Horizontal ray correctly drawn passing through the second focal point.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Both rays shown not meeting.	1 mark
Direction arrows on each line.	1 mark
Total: 4 marks	

(Total for Question 9 is 4 marks)

10. Complete the ray diagram for the lens in the figure below.



Horizontal ray correctly drawn being refracted away from the lens.	1 mark
Ray drawn passing straight through the optical centre of the lens.	1 mark
Line drawn from the x axis to where the imaginary ray meets the real ray.	1 mark
Direction arrows on each line.	1 mark
Total: 4 marks	

(Total for Question 10 is 4 marks)