



# HARROW SCHOOL

## PRELIMINARY ENGLISH SCHOLARSHIP EXAM 2024

**1½ hours**

### **Instructions:**

- This paper is in two sections worth equal marks; you are advised to divide your time evenly between the two.
- In both responses you will be marked for the quality of your writing (spelling, grammar and punctuation).
- Please begin your response to Section B on a new piece of paper.

## SECTION A: READING

*Read the following poem and answer the question that follows.*

### **The Donkey**

**By G. K. Chesterton**

When fishes flew and forests walked  
And figs grew upon thorn,  
Some moment when the moon was blood  
Then surely I was born.

With monstrous head and sickening cry  
And ears like errant wings,  
The devil's walking parody  
On all four-footed things.

The tattered outlaw of the earth,  
Of ancient crooked will;  
Starve, scourge, deride me: I am dumb,  
I keep my secret still.

Fools! For I also had my hour;  
One far fierce hour and sweet:  
There was a shout about my ears,  
And palms before my feet.

**How does the poet convey the thoughts and feeling of the Donkey in his poem?** *Be sure to use quotations from the passage in your response.*

**[25 marks]**

## **SECTION B: WRITING**

Choose **one** of the following titles or themes for a composition. You may choose to write a piece of description, or a story. Spend some time planning before you start to write.

**[25 marks]**

**EITHER:**

*Arriving in a Strange Country*

**OR:**

*The Need to Slow Down*



# HARROW SCHOOL

## **French Scholarship Examination 2024**

**60 Minutes**

- *Section 1 : Text and reading comprehension*
- *Section 2 : Text and retranslation*
- *Section 3 : Translation into French*
- *Section 4 : 130-200 word response in French*

*Write your answers on the question paper using blue or black ink.  
Ensure that you write your name on the paper !*

Name \_\_\_\_\_

**1. Read the passage from *Le Grand Meaulnes*. Find the English expressions; write them in French, exactly as they are in the text. You will be penalised for incorrect spelling and missed accents.**

Samedi 13 février – J’ai rencontré, sur le quai, cette jeune fille qui m’avait renseigné au mois de juin, qui attendait comme moi devant la maison fermée ... Je lui ai parlé. Tandis qu’elle marchait, je regardais de côté les légers défauts de son visage : une petite ride au coin des lèvres, un peu d’affaissement aux joues, et de la poudre accumulée aux ailes du nez. Elle s’est retournée tout d’un coup et me regardant bien en face, peut-être parce qu’elle est plus belle de face que de profil, elle m’a dit d’une voix brève :  
« Vous m’amusez beaucoup. Vous me rappelez un jeune homme qui me faisait la cour, autrefois, à Bourges. Il était même mon fiancé ... »

Cependant, à la nuit pleine, sur le trottoir désert et mouillé qui reflète la lueur d’un bec de gaz, elle s’est approchée de moi tout d’un coup, pour me demander de l’emmener ce soir au théâtre avec sa sœur. Je remarque pour la première fois qu’elle est habillée de deuil, avec un chapeau de dame trop vieux pour sa jeune figure, un haut parapluie fin, pareil à une canne.

- | • Example : Saturday 13th February | <b>Samedi 13 février</b> |
|------------------------------------|--------------------------|
| 1. In the middle of the night      | _____                    |
| 2. Whilst she was walking          | _____                    |
| 3. I met                           | _____                    |
| 4. She turned around               | _____                    |
| 5. All of a sudden                 | _____                    |
| 6. She said to me                  | _____                    |
| 7. A women’s hat                   | _____                    |
| 8. A little wrinkle                | _____                    |
| 9. She is dressed in mourning      | _____                    |
| 10. You remind me of a young man   | _____                    |

*(10 marks)*

**2. Read the translated sections of text. Adapt the original language to complete the translation. Check verb forms, singular / plural nouns and adjectives etc.**

- Example

*Cette jeune fille* : that young girl

→ Those young boys :

**Ces jeunes garçons**

1. *Devant la maison fermée* : In front of the closed house

→ Behind the closed houses :

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2. *Elle est plus belle* : She is more beautiful

→ He is less beautiful :

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3. *Je remarque pour la première fois* : I notice for the first time

→ We noticed for the last time :

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4. *Elle s'est approchée de moi* : She approached me

→ He approached you :

---

5. *Il était même mon fiancé* : He was even engaged to me

→ She will even be engaged to him :

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(15 marks)

**3. Translate the sentences into French using the verb(s) provided:**

a) I go to bed. (se coucher)

---

b) We tidy the living room. (ranger)

---

c) She will not know. (savoir)

---

d) You (use 'vous') would like to help me. (vouloir / aider)

---

e) Caroline and Anne arrived by car. (arriver)

---

f) They (use 'ils') are going to play in the garden. (aller + infinitif)

---

g) I had written a long letter. (écrire)

---

h) Michel and Paul got dressed. (s'habiller)

---

i) You (use 'tu') drink nothing. (boire)

---

j) He was finishing his breakfast. (terminer)

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*(30 marks)*

**4. You are writing an article in French for your school website about different aspects of your life. It can be a true or imaginary account.**

**You will describe 1) what you like reading and why it is important to read ; 2) how you have helped your parents recently ; 3) what your ideal school day would be like ; 4) where you will go on holiday this summer.**

**Answer in the spaces provided. Aim to write 35-50 words per question. Do not exceed 200 words in total (focus on accuracy rather than quantity) – 40 marks.**

1. Explique ce que tu aimes lire et pourquoi il est important de lire.

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2. Comment as-tu aidé tes parents récemment ?

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3. Décris une journée idéale au collège.

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4. Où vas-tu aller en vacances cet été ?

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# HARROW SCHOOL

## Geography Scholarship Examination 2024

**60 Minutes**

This exam consists of **two** sections.

Section 1 consists of four and six mark questions.

Section 2 consists of a choice of four, twenty mark essays. Select and answer **one question only**.

You are advised to spend 30 minutes on Section 1 and 30 minutes on Section 2.

Answer all questions in the space provided.

Clearly name any extra paper used.

Use blue or black ink for written text.

You may use a pencil for diagrams.









## SECTION 2

*[Spend 30 minutes on this section]*

Answer any **one** of the following essay questions and in each case **refer to specific examples, places and processes**. Try and write a balanced answer which shows **both sides of an issue**.

**Credit will be given** for the use of named and located examples, and the use of well-labelled sketch maps and diagrams, where appropriate.

### EITHER

1. 'Managing climate change involves both reducing causes (mitigation) and responding to change (adaptation)' Do you agree? **[20 marks]**

### OR

2. 'Economic activity will always have major environmental impacts on natural systems' Do you agree? **[20 marks]**

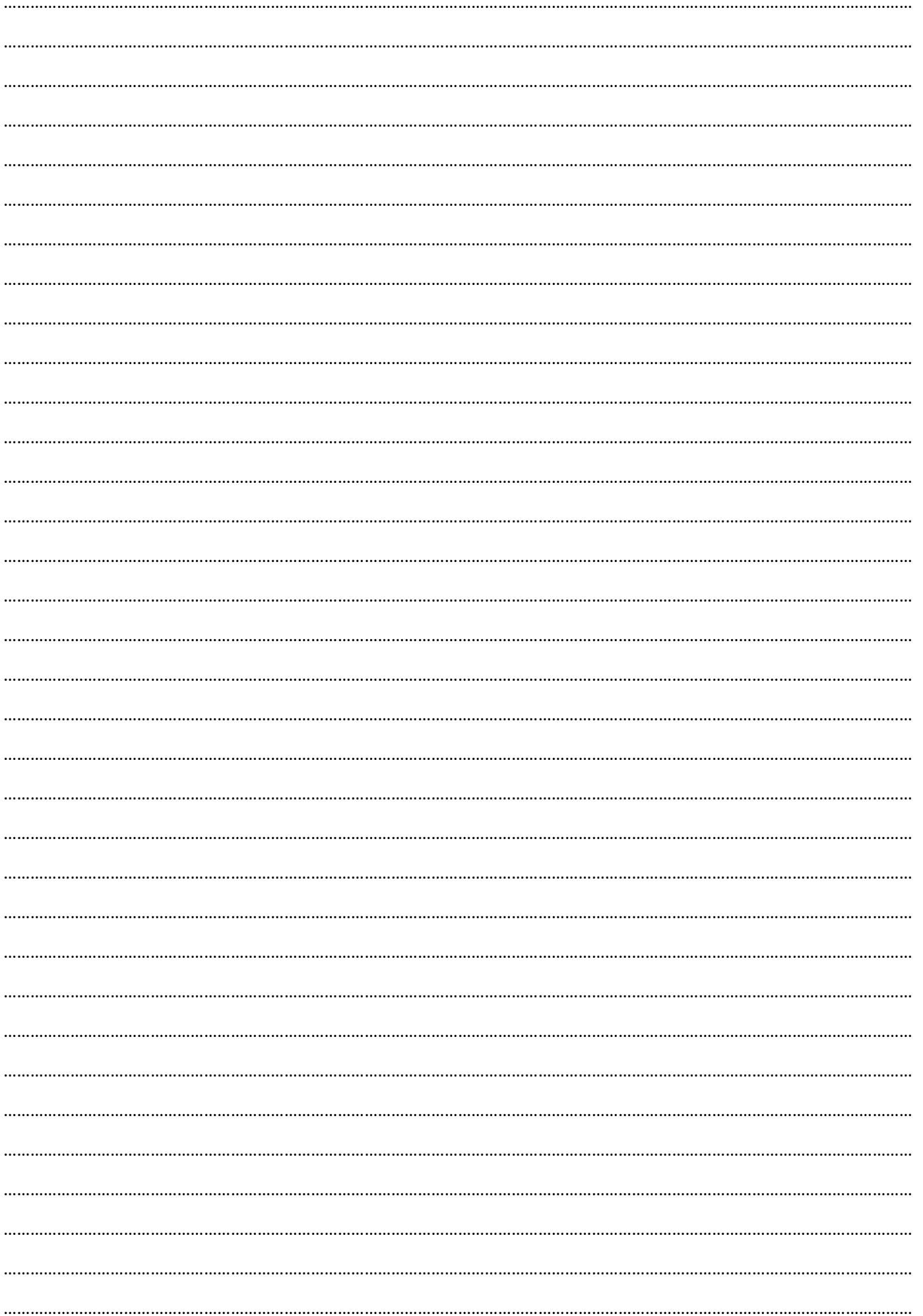
### OR

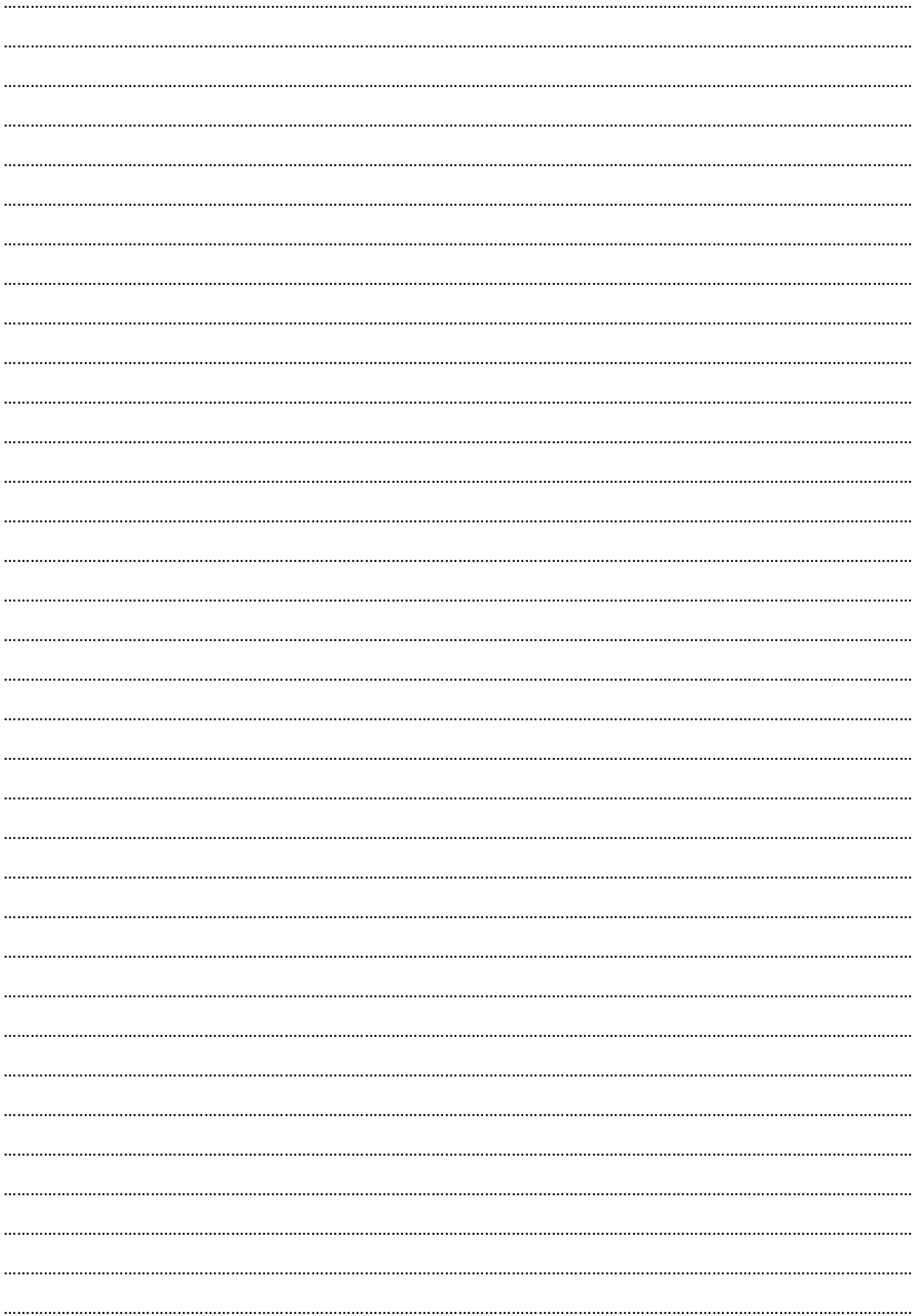
3. 'Long term responses to tectonic hazards are more important than immediate responses.' Do you agree? **[20 marks]**

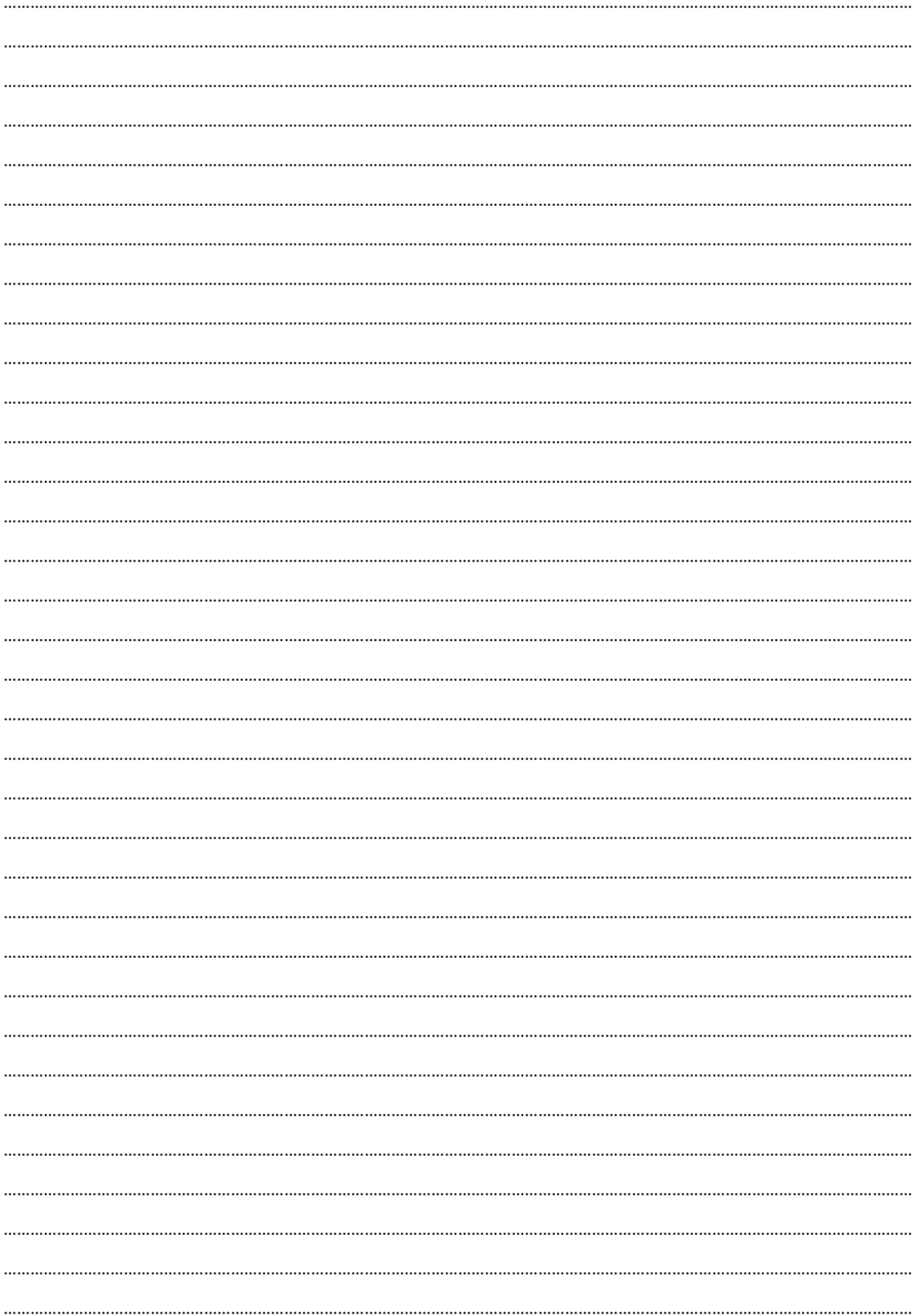
### OR

4. Assess the effectiveness of a strategy (or strategies) of your choice in resolving a geographic issue **such as** food production and supply, energy and sustainability, water security, population growth, biodiversity loss. **[20 marks]**

Space to plan your answer:











# HARROW SCHOOL

ENTRANCE SCHOLARSHIPS EXAMINATION 2024

## **CLASSICAL GREEK** **1 hour**

### *GENERAL INSTRUCTIONS:*

*You must attempt all questions.*

*You should make an intelligent guess at words you do not know, using your knowledge of English vocabulary.*

*Try to base any guesses on elements in the sentence that you definitely DO know and make sure that they make sense in context.*

*Use blue or black ink.*

**SECTION A: Reading and Grammar (50 marks)**

**1 Identify the following Greek proper names by transliterating the Greek.**

- (a) Ποσειδων
- (b) Ασκληπιος
- (c) Χαριτες
- (d) Επιμηθευς
- (e) Εχιδνα

[5]

**2 Transliterate the following English into Greek (i.e. write them in Greek letters). Long vowels (eta, omega, etc.) are indicated with a mark (e.g. 'ê' or 'ô'). Remember to add breathings where appropriate.**

- (a) Iapetos
- (b) Astraios
- (c) Endymiôn
- (d) Hêphaistos
- (e) Psykhê

[5]

**3 Change the following nouns from plural to singular, keeping the same case. Write out the Greek singular form and give the basic meaning of each word.**

**Example:** τους δουλους = τον δουλον (slave)

- (a) ταις χωραις
- (b) τους κριτας
- (c) των âγρων
- (d) τα δωρα
- (e) οί δουλοι

[10]

4 **Change the following nouns from singular to plural, keeping the same case. Write out the Greek plural form and give the meaning of each word.**

(a) το πλοιοιν

(b) τον άγρον

(c) της χωμης

[6]

5 **Change the following verbs from single to plural, or plural to single, keeping the same person and tense. Then translate your answer.**

(a) ει

(b) λειψω

(c) έχομεν

(d) έλιπον

(e) άπέκτεινες

[10]

6 **The following English words are derived from Greek words. What do they mean in English?**

**Write down any Greek work you might know related to the English word.**

(a) stylograph

(b) geology

(c) astronomy

(d) cosmopolitan

(e) xenophobia

(f) strategy

[6]

7 **Write out any TWO of the following:**

(a) The full future of πεμπω.

(b) 2<sup>nd</sup> declension f. noun ή βιβλος in all its cases (singular & plural).

(c) Decline the pronouns έγώ and συ.

(d) The masculine definite article (singular & plural).

[8]

**SECTION B: Sentences and Composition (35 marks)**

**1 Translate into English:**

- (a) ἀρ' ἔχεις την μικραν βιβλον, ὦ διδασκαλε; [4]  
(b) τίς ἐστίν ὁ βασιλεύς ὁ μετα τῶν στρατιωτων; [4]  
(c) οὐ πιστεύσω τοῖς τοῦ στρατηγοῦ λόγοις. [3]  
(d) ὁ ἄγγελος ἔλεγεν ἐν τῇ ἐκκλησίᾳ. [4]  
(e) φυλάξομεν τὰς τῶν φίλων οἰκίας. [4]

**2 Translate into Greek:**

- (a) The sailors have beautiful boats. [5]  
(b) Brave men were guarding the country. [5]  
(c) You hear (pl) the shouts of the slaves. [5]

### SECTION C: Translation (30 marks)

Translate the passage into good English. Write your translation on alternate lines. Vocabulary is given at the foot of the page. Try to identify the proper names mentioned in the passage.

#### The Persian Invasion

*Intent on punishing Athens for helping rebels, Darius the king of the Persians, sent an expedition to Greece in 490 BC. The Persians landed at Marathon in Attica.*

ὁ δὲ Δάρειος, ὁ τῶν Περσῶν βασιλεύς, στρατιὰν μεγάλην πρὸς τὰς Ἀθήνας ἔπεμψεν. “νικήσω γὰρ τοὺς Ἀθηναίους,” ἔφη, “καὶ ἄρξω πάντων τῶν Ἑλλήνων.” οἱ οὖν στρατιῶται οἱ τοῦ βασιλέως ἔπλευσαν ἐν πολλαῖς ναυσὶ πρὸς τὸν Μαραθῶνα, κώμην τῆς Ἀττικῆς ἐγγύς τῆς θαλάσσης. οἱ δὲ Ἀθηναῖοι ἄγγελον ταχύν πρὸς τὴν Λακεδαίμονα ἔπεμψαν. ὁ δὲ ἄγγελος, Φιλιππίδης ὀνόματι, ἐν τοῖς ἄγροις ἔτρεχε, καὶ ἐξαίφνης τὸν Πᾶνα εἶδεν. ὁ δὲ θεός, “διώξω,” ἔφη, “τοὺς Πέρσας ἐκ τῆς Ἑλλάδος.”

οἱ δὲ Λακεδαιμόνιοι, συμμαχοὶ τῶν Ἀθηναίων, ἑορτὴν ἤγον. “στρατιὰν πέμψομεν,” ἔφασαν, “μετὰ τὴν ἑορτὴν.” ἐπεὶ δὲ οἱ Ἀθηναῖοι ἤκουσαν τοὺς τῶν Λακεδαιμονίων λόγους, “πιστεύσομεν,” ἔφασαν, “τοῖς θεοῖς. οἱ γὰρ Ἕλληνες οὐ δουλεύσουσι τοῖς βαρβάροις.”

#### Vocabulary

νικήσω: I shall defeat

ἔφη: he said

ἄρξω: I will rule over + gen.

ἔπλευσαν: sailed

ἐγγύς + gen: near

ταχύν: fast

Λακεδαίμων -ονος ἡ: Sparta

ἐξαίφνης: suddenly

Πάν Πανός ὁ: Pan (the famous demi-god, half man, half goat)

οἱ Πέρσαι: the Persians

ἡ Ἑλλάς, Ἑλλάδος: Greece

εἶδον: I saw

ἑορτή -ῆς ἡ: festival

ἄγω: (here) I celebrate

ἔφασαν: they said

μετὰ + acc: after

δουλεύσουσι: they will be slaves



# HARROW SCHOOL

## History Scholarship Examination 2024

**Time: 90 Minutes**

*There are three sections in this examination.*

*You are advised to spend approximately 30 minutes on each section.*

*The quality of your answers is more important than the quantity, so spend 5-10 minutes thinking and 20-25 minutes writing for each section.*

*Each section is worth 30 marks in total.*

## SECTION A

*Read the background information, and study both sources. Then answer **both** questions.*

### **Background information: The League of Nations**

After the First World War everyone wanted to avoid repeating the mass slaughter of the war that had just ended. It was agreed that a League of Nations should be established - an organisation that could solve international problems without resorting to war. This would help ensure that there was a long-lasting peace throughout the world.

The American President, Woodrow Wilson (President of the United States 1913-1921), wanted the League of Nations to be a world parliament where representatives of all nations could meet regularly to decide on any matters that affected them all. Many British leaders thought the best League would be a simple organisation that would just get together in emergencies. France proposed a strong League with its own army.

The League of Nations faced many difficult problems after its official establishment on 10 January 1920. Its critics claim that it achieved little and point to the fact that another world war broke out in 1939. Its defenders argue that although it did eventually fail to prevent another world war, it had several successes.

Overall, how far was the League of Nations a failure?

### **Source A: An extract from a speech made by Seán Lester, Secretary-General of the League of Nations. He was speaking to the Assembly during the last session of the League in 1946, when it dissolved itself.**

It is common to speak of the failure of the League. Is it true that all our efforts for those twenty years have been thrown away? The work of the League is unmistakably printed on the social, economic and humanitarian life of the world. But above all that, a great advance was made in the international organisation of peace. For the first time an organisation was constructed to abolish war. An Assembly [The League's Parliament] representing some fifty peace-loving nations.

For ten years the League advanced. Our balance-sheet is not altogether unfavourable. In the essential task of maintaining peace it succeeded during a number of years. It succeeded as long as the governments of the Great Powers supported it and as long as, in the background, there was the possibility that their force would be put at the service of its decisions. During a number of years the League of Nations settled various grave disputes such as the Aaland Islands, all of them involving areas which might have become battlefields if the League had not settled them.

### **Source B: An extract from a speech made by Maxim Litinov at the League of Nations Assembly [Parliament] in September 1938. Litinov was in charge of the foreign policy of the Soviet Union between 1930 and 1939**

There exist inside the League two ideas about how best to preserve peace. There is the idea that when a state announces a foreign policy based on aggression and invading other countries' frontiers, the League has the duty of declaring that it will fight such a policy with every means at its disposal.

There is, however, another idea that the aggressor should be treated with consideration and that negotiations should be carried out with the assurance that no collective action will be carried out. Unfortunately, this is the policy that has so far been followed and it has as its consequences three wars and threatens to bring us a fourth.

## **Questions**

### **Question 1**

Study Source A. Explain in your own words what Seán Lester means when he states that the League of Nations, 'succeeded as long as the governments of the Great Powers supported it.' [10 marks]

### **Question 2**

Study Sources A and B. On the basis of the evidence provided by these two sources, to what extent can the League of Nations be considered a success? [20 marks]

## **SECTION B**

Answer **ONE** of these questions.

### **Either**

3. 'Kind and generous leaders have never been successful in the past.' How far do you agree with this statement? Explain your answer. [30 marks]

### **or**

4. 'History is determined by the people and not by those in power.' How far do you agree with this statement? Explain your answer. [30 marks]

## SECTION C

5. Study Source C and Source D below. What information do these two sources provide about the significance of events in Europe between 1914 and 1945? [30 marks]

### Source C



*A train carriage in Le Francport, Forest of Compiègne, France - 5:45am - 11 November 1918*

### Source D



*A photograph taken in a train carriage in Le Francport, Forest of Compiègne, France - 6:36pm - 22 June 1940*



# HARROW SCHOOL

ENTRANCE SCHOLARSHIPS EXAMINATION 2024

**LATIN**

**1 ½ hours**

*GENERAL INSTRUCTIONS:*

*You must attempt all questions in Section A: Translation, Section B: Comprehension, and Section C: Grammar and Translation.*

*You should make an intelligent guess at words you do not know, using your knowledge of English vocabulary and the English introduction to each passage.*

*Try to base any guesses on elements in the sentence that you definitely DO know and make sure that they make sense in context.*

*Use blue or black ink.*

**[85 marks]**

## Section A: Translation

Translate the passage into good English. Use alternate lines.

*AD 61, Boudica the queen of the Iceni people rebelled against the Romans in Britain.*

Iulius Caesar Britanniam vincere non poterat. sed post centum annos, Claudius imperator cum maximo exercitu invasit et Romani in Britannia quattuor saecula manebant. primo Romani saepe crudeles erant et multae gentes Britanniae Romanos non amabant. inter eas erant Iceni, quos regebat femina fortis et audax, nomine Boudicca. marito mortuo, Boudicca suos duxit ut tres urbes, quas Romani in Britannia iam aedificaverant, incenderent. has urbes deleverunt ut Romanos ex insula discedere cogerent. praefectus Romanus tamen, qui contra Druidas Monae pugnabat, subito Londinium cum legione festinavit. hanc urbem servare non poterat sed exercitum duxit ut barbaris resisteret. barbari mox fessi erant sed regina speravit se Romanos superaturam esse. tamen in medio proelio autem Boudicca vidit Romanos facile vincere et se veneno occidit ne a Romanis caperetur.

### Names

Britannia, f.	Britain
Iulius Caesar m.	Julius Caesar
Claudius, m.	Claudius (the Roman emperor)
Druidas	Druids
Mona, -ae f.	the island of Anglesey

### Vocabulary

saeculum,-i	century
praefectus, -i m.	governor
venenum,-i	poison

[30 marks]



**Answer all questions.**

1. What was Porsenna the king unable to do? (line 1) [2]
2. Where did Porsenna put his military camp? (line 2) [4]
3. Who was Cloelia? (line 2-3) [2]
4. When did Cloelia and the other girls run away? (line 3) [4]
5. How did Porsenna react when he heard the girls were gone? (line 4) [2]
6. Why did he send soldiers? (line 4-5) [2]
7. What did the soldiers order the Romans to do? (line 5) [3]
8. Because the king had admired Cloelia, why did he send the soldiers back again to Rome? (line 6) [2]
9. What was the reason the king gave for not keeping Cloelia? (line 7) [2]
10. What did the king say he wanted to do instead? (line 8) [2]

**[25 marks]**

## Section C: Grammar & Composition

*Cloelia, a hostage given to King Porsenna, acts bravely.*

Porsenna rex, qui Romam capere non poterat, urbem obsidere constituit. ille, cui Romani obsides dederunt, castra non procul a ripa Tiburis posuit. una ex obsidibus erat puella nomine Cloelia. illa cum aliis puellis, custodibus non spectantibus, effugit ut trans flumen nataret. Porsenna iratissimus, cum puellas fugisse audivisset, milites Romam misit ut  
5 obsides reciperent. "Romani", inquit "Cloeliam nobis tradite". mox tamen rex, cum  
puellam admiratus esset, iterum milites Romam misit ut puellam redirent. "nolite" inquit  
"Cloeliam obsidem Porsennae dare. haec puella est tam fortis, ut rex audaciam eius laudet.  
8 rex autem dicit se alios ex obsidibus ad vos remittere velle." deinde Cloelia multos iuvenes  
elegit ut liberarentur.

Answer the following grammar questions about the passage you have just read.

1. What tense is *poterat* in line 1? [1]
2. What case is *cui* in line 1? [1]
3. What case is *aliis puellis* in line 3 and explain why it is in that case? [2]
4. Explain the form of *nataret* in line 4, and say why it is in that form. [2]
5. Explain the form of *tradite* in line 5. [2]
6. What case is *Romani* in line 5? [1]
7. What tense is *misit* in line 6? [1]
8. Identify a preposition in line 8. [1]
9. Identify a verb in the pluperfect tense. [1]
10. Identify a reflexive pronoun. [1]
11. Identify a noun in the accusative case. [1]
12. Identify an ablative absolute from the passage. [1]

[15 marks]

### Translation

Translate the following sentences into Latin.

1. I sailed to my country at last. [4]
2. The men were guarding the walls of the city. [4]
3. Why do you not have a sword? [4]
4. I was not able to run to the ship. [3]

[15 marks]

Surname:	First name:
Current School:	



# HARROW SCHOOL

## MATHEMATICS PAPER 1 SCHOLARSHIP EXAMINATION 2024

90 minutes

### **Instructions to Candidates**

- Use BLACK ink only.
- Calculators and geometrical instruments may be used.
- Show all your working. Answers with no working may not score full marks.
- Write your answer to each question in the space following the question.

### **Information for Candidates**

- The marks available for each question are indicated in square brackets.
- Full marks may be obtained for answers to ALL questions.
- This paper has **17** questions.
- The total number of marks available is **100**.

**Section A (60 marks)**

1.  $S = ut + \frac{1}{2}at^2$

- (a) Work out  $S$  when  $u = 11.2$ ,  $t = 2.5$ ,  $a = 9.8$ .  
Show clear working before leaving your answer correct to 1 decimal place.

..... (2)

- (b) Work out  $a$  when  $u = -7.2$ ,  $S = 98$ ,  $t = 3.3$   
Show clear working before leaving your answer correct to 3 significant figures.

..... (3)

2.

(a) Solve the following without using the calculator, showing all steps clearly.

$$4\frac{1}{5} - 2\frac{2}{3} =$$

..... (2)

(b) Solve the following without using the calculator, showing all steps clearly.

$$5\frac{1}{4} - 3\frac{1}{2} \times 1\frac{2}{3}$$

..... (3)

3. (a) Express as a single fraction

$$\frac{x}{3} - \frac{3x}{2}$$

..... (2)

(b) Express as a single fraction

$$\frac{y+1}{2} - \frac{y-1}{7}$$

..... (3)

(c) Express as a single fraction

$$\frac{5}{z-3} - \frac{5}{z-1}$$

..... (3)

4. (a) Solve  $3(x - 3) - x^2 = x - x(x + 2)$

$x = \dots\dots\dots$  **(3)**

(b) Solve  $\frac{3x-1}{2} = \frac{x-7}{3} - 1$

$x = \dots\dots\dots$  **(4)**

(c) Solve  $\frac{3}{4}(x - 1) - \frac{2}{3}(3x + 1) = \frac{1}{5}(x + 1)$

$x = \dots\dots\dots$  **(4)**

(d) Solve for the value of  $p$  if

$$\frac{25}{4} = \frac{2}{5}(p - 3)^3$$

$p = \dots\dots\dots$  **(4)**

5. (a) Factorise  $25xy - 50y$

$\dots\dots\dots$  **(1)**

(b) Factorise fully  $30y^2 - 12xy$

$\dots\dots\dots$  **(1)**

(c) Factorise fully  $\frac{35}{2}x^3y - \frac{49}{8}x^2y^2$

$\dots\dots\dots$  **(2)**

6. (a) Make  $p$  the subject of  
 $2a = 3 - 4p$

$$p = \dots\dots\dots (2)$$

- (b) Make  $p$  the subject of  
 $a = c + \frac{7}{p}$

$$p = \dots\dots\dots (2)$$

- (c) Make  $p$  the subject of

$$a^2 = b^2 + (p - 5)^2$$

$$p = \dots\dots\dots (4)$$

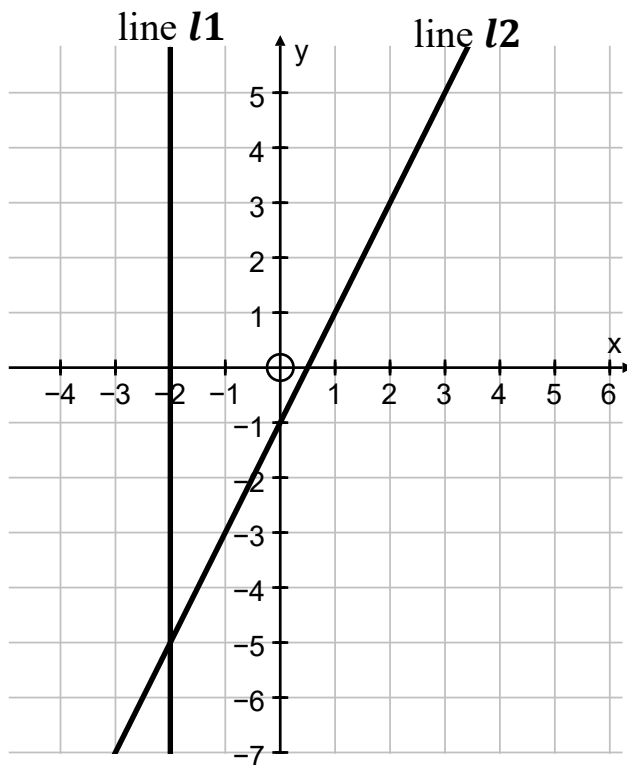
- (d) Make  $p$  the subject of  
 $p - 3 = 3 - a(1 - 2p)$

$$p = \dots\dots\dots (4)$$

7. I think of two numbers.  
 When I double the first one and add on the second, I get 17.  
 When I treble the first one and subtract the second one, I get 18.

The numbers are.....and..... (4)

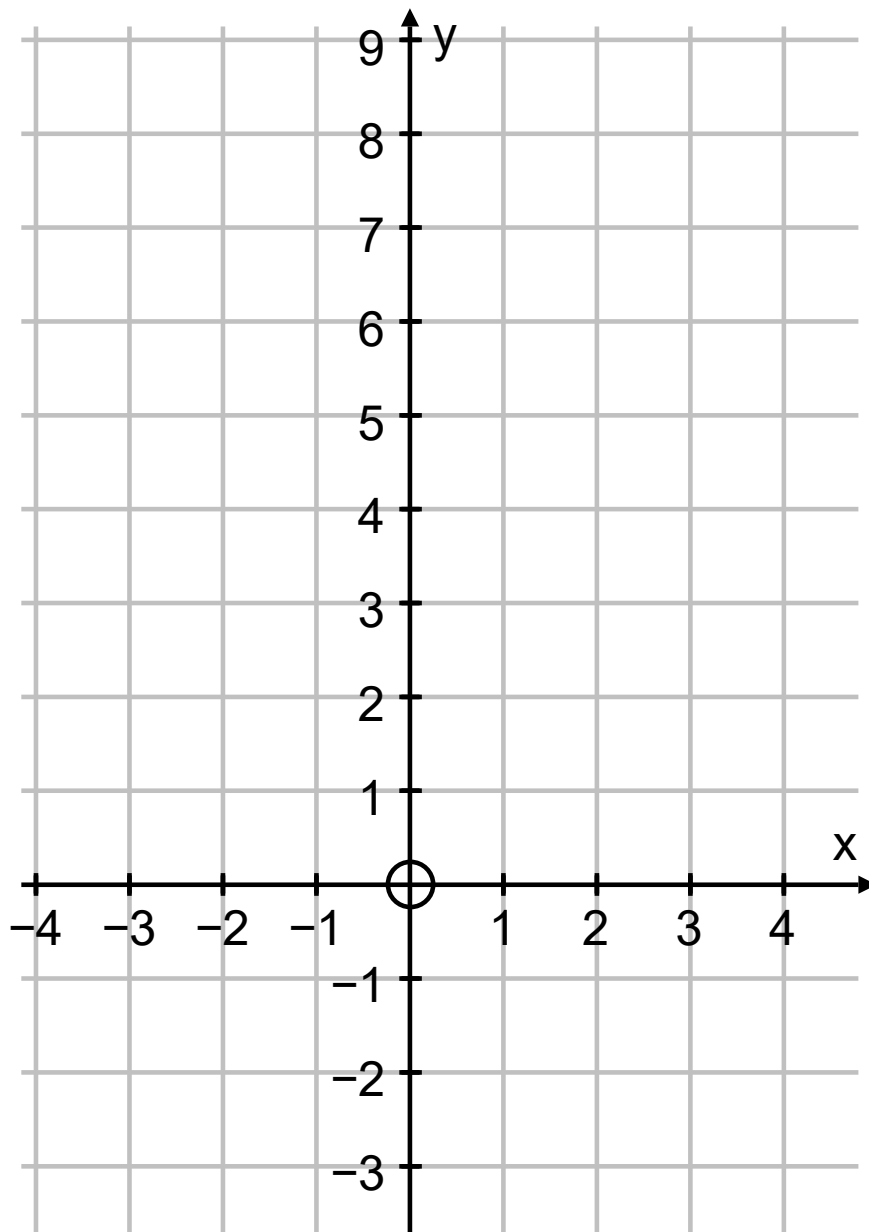
8. (a) Write down the equation of these two lines



line **l1** : .....(1)

line **l2** : ..... (2)

- (b) On the axes below draw and label clearly the following two graphs:  
 $y = -2x + 1$  and  $y = x^2 - 2$ .



(4)

**Section B (40 marks)**

9. The size of the largest angle in a quadrilateral is 3 times the size of the smallest angle. The other two angles are equal size and are  $25^\circ$  less than the largest angle. Work out the size of each angle in the quadrilateral.

[You must show algebraic working. Solutions by trial and improvement will gain no mark.]

..... $^\circ$ , ..... $^\circ$ , ..... $^\circ$ , ..... $^\circ$  (5)

10. The length of each side of square B is 3 cm greater than the length of each side of square A. The area of square B is  $60 \text{ cm}^2$  greater than the area of square A. Find the area of square B.

[You must show algebraic working. Solutions by trial and improvement will gain no mark.]



**A**



**B**

Area of square B = ..... (5)

11. Given that

$$3 \Delta 4 = 13$$

$$5 \Delta 2 = 27$$

$$8 \Delta 1 = 65$$

$$7 \Delta 7 = 56$$

Find the value of  $9 \Delta 9$ .

..... (2)

12. Joss took a number of Maths tests. One of his scores was 75 marks and his average score was 86 marks. When the score of 75 marks was changed to 95 marks, his average score became 90 marks. How many tests did Joss take?

No of tests = ..... (3)

13. Study the following pattern:

$$\begin{aligned}3^2 - 2^2 &= 5 = 3 + 2 \\5^2 - 4^2 &= 9 = 5 + 4 \\7^2 - 6^2 &= 13 = 7 + 6\end{aligned}$$

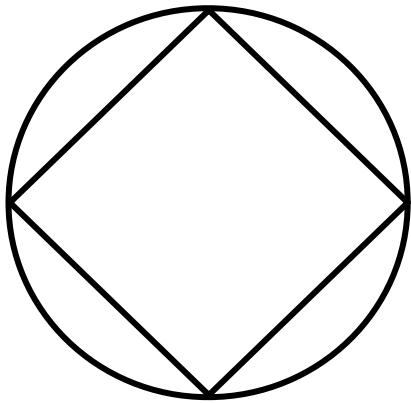
(a) Find the value of  $41^2 - 40^2$

..... (1)

(b) Find the value of  $1^2 - 2^2 + 3^2 - 4^2 + 5^2 - \dots - 40^2 + 41^2$

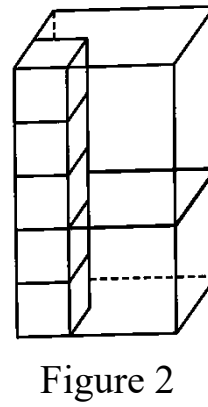
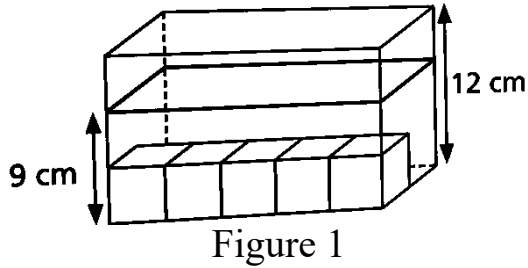
..... (4)

14. In the following diagram, a square is inscribed in a circle. Given that the square has a side of 7 cm, find the area of the circle. (Take  $\pi = \frac{22}{7}$ )



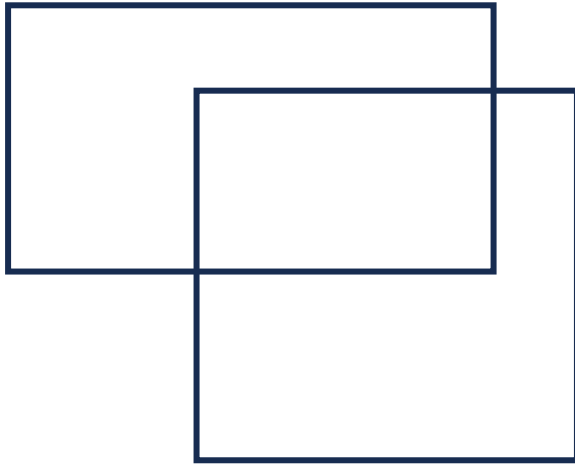
Area of Circle = ..... $cm^2$  (5)

15. Figure 1 below shows a closed rectangular container that is filled with some water and 5 identical cubes. The base area of the rectangular container is  $500 \text{ cm}^2$ . The rectangular container was then turned upright as shown in Figure 2. Find the volume of water in the container in  $\text{cm}^3$ .



Volume of water in container = .....  $\text{cm}^3$  (5)

16. The diagram below shows a rectangle and a square that overlaps. The overlapped part is  $\frac{2}{5}$  of the square and  $\frac{3}{7}$  of the rectangle. Given that the area is  $276 \text{ cm}^2$ , find the area of the square.



Area of square = ..... (5)

17. Kat and Craig started cycling from Park P to Park Q at the same time. Kat cycled at an average speed of 20 mph while Craig cycled at an average speed of 12 mph. After cycling for 2 h, Kat decided to turn back and cycle towards Craig. Kat met Craig at Point X which was halfway between Park P and Park Q. What was the distance between Park P and Park Q?

..... (5)

**End of Paper**



# HARROW SCHOOL

Scholarship Examination 2024

# Mathematics II

Time: **90 Minutes**

## **Instructions and advice:**

Write your solutions on lined paper, using blue or black ink or pencil. Calculators, geometric instruments (protractor, set square, compass etc.) and squared paper may NOT be used.

Write on only one side of the paper and start your answer to each question on a fresh sheet. Make sure the question number and your name are clearly written on each sheet.

**This paper is designed to be very challenging.**

Very few (if any) candidates should expect to finish it.

Greater credit will be given for a smaller number of complete solutions to some of the questions rather than a larger number of incomplete attempts.

You do not need to attempt the questions in the order in which they are presented (indeed, you are advised to first read all the questions then start by attempting those with which you feel the most comfortable).

**You must show all your working and explain all your reasoning.**

**PLEASE NOTE: This paper is not just about getting the right answers; correct answers on their own will earn few marks. You will be marked more on the PRESENTATION of your solutions, the EXPLANATION of your working and the JUSTIFICATION of your final answers.**

---

1. In this question, you should use the approximation  $\pi \approx 3\frac{1}{7}$ .

A goat is tethered with a rope to a post in the corner of a square field. The length of the side of the field is  $\sqrt{77}$  metres.

It can walk freely around in the field to any point which is no further than the length of the rope from the post.

It turns out that the goat can reach exactly half of the field.

How long is the rope?

2. The length of the 1<sup>st</sup> XI football pitch at Harrow, *when rounded to the nearest metre*, is 84m.
- What is the shortest length that the pitch could be (which would still round up to 84m)?  
This is called the **lower bound** of its length.
  - What is the shortest length that the pitch could be which would no longer round down to 84m?  
This is called the **upper bound** of its height.

If the length of the pitch is  $p$ , we can write Lower Bound  $\leq p <$  Upper Bound.

- Notating your answers as above, determine the upper and lower bounds of the following:
  - $a = 8\text{cm}$  to the nearest cm;
  - $b = 220\text{g}$  to the nearest 10g;
  - $c = 220\text{g}$  to the nearest 1g;
  - $d = 3400$  litres to three significant figures.
- Given that  $v = 32$  (to the nearest whole number) and  $w = 0.7$  (to one decimal place), find:
  - the upper bound of  $v \times w$
  - the lower bound of  $2v + 30w$
  - the lower bound of  $2v - 30w$
  - the difference between the upper bound and lower bound of  $\frac{v}{w}$
- Bunches of bananas are stored in crates. Given that a bunch of bananas weighs 1kg to the nearest 100g and that a crate can hold 110kg (to the nearest 10kg) before it breaks, find the maximum number of bunches of bananas that can safely be put into a crate so that there is no risk of its breaking.

3. Alan cycles to work. He knows that, if he cycles at 18km/h, he will arrive 15 minutes early, but if he cycles at 12km/h, he will arrive 15 minutes late.

At what speed should he cycle to ensure he arrives exactly on time?

4. Estimate how many standard sheets of A4 paper it would take to completely cover the outside of a house. You should state any assumptions that you make.

5. In this question, the notation  $S_n(k)$  is used to mean the sum of the first  $n$  multiples of  $k$ , where  $n$  and  $k$  are positive integers. You are given that  $S_n(k) = \frac{1}{2}kn(n+1)$ ; you can use this formula without proof.
- Find  $S_{15}(4)$ .
  - Find the sum of all the multiples of 7 which are less than 200.
  - Find the sum of all the three-digit multiples of 12.  
*You are given that  $12 \times 83 = 996$*
  - Find the sum of the first 40 multiples of 3 which are not multiples of 9.
  - Find the sum of all the numbers below 100 which are not multiples of 2 or 3.
6. Regardless of the value of  $A$  and  $B$ , it is true that  $A^2 - B^2 = (A + B)(A - B)$ . This is known as the factorisation of the *difference of two squares*.  
For example, if  $A = 6$  and  $B = 2$ , then  $A^2 - B^2 = 36 - 4 = 32$ , and  $(A + B)(A - B) = 8 \times 4$ , which is also 32.
- Find the value of  $125^2 - 75^2$ .
  - Find the value of  $1012 \times 988$ .
  - $M = 309^2 - 141^2$ . Write  $M$  as a product of its prime factors.
  - You are given that the number  $1001 = 7 \times 11 \times 13$ .
    - Write down the four different pairs of factors that multiply to give 1001.
    - Find all the different pairs of square numbers which differ by exactly 1001.
  - Is it possible to have two integers  $m$  and  $n$  such that  $n^2 = m^2 + 54$ ? Justify your answer.
7. While in a hurry in a Maths lesson, Kieran wrote down the “double-decker” fraction  $\frac{48}{\frac{12}{2}}$ . When he came back to his notes later, he realised he couldn’t tell whether he’d meant  $\frac{\left(\frac{48}{12}\right)}{2}$  or  $\frac{48}{\left(\frac{12}{2}\right)}$ .
- What are the two values his original fraction could have represented?
- He decides to investigate these ambiguous fractions further, and starts to think about the general fraction  $\frac{a}{\frac{b}{c}}$   
(where  $a$ ,  $b$  and  $c$  are all integers greater than 1).
- Of the two possible different numbers this fraction could represent, one is always bigger than the other. Which one? Justify your answer.
  - Find an expression (in the form of a single, fully-simplified fraction) for the difference between the two.
- Kieran then decides to investigate further, so considers  $\frac{\frac{p}{q}}{\frac{r}{s}}$ , where  $p$ ,  $q$ ,  $r$  and  $s$  are all integers greater than 1.
- Find how many different possible values there are that this fraction could represent. Write them all as simplified single-decker fractions. Determine, with justification, the largest and the smallest of them.
  - There are two of these values that can be equal to each other. Determine which two and also the conditions for them to be equal.

**END OF PAPER**

*There are no questions printed on this page.*



**HARROW**  
SCHOOL

**Philosophy and Applied Ethics  
Scholarship Examination 2024**

**75 minutes**

*You have 30 minutes to read through reading on Book VII of The Republic and then 45 minutes to answer the question. Do take time to plan and draft your answer.*

*Use blue or black ink for text.*

**The Greek philosopher Plato wrote most of his work in the form of dialogues between his old teacher Socrates and some of Socrates' followers and critics. This particular story comes from Plato's book of philosophical fiction, *The Republic*. In *The Republic*, Socrates tells his follower Glaucon a story about people living in a cave, which serves as an allegory for human society and the pursuit of knowledge.**

*from Book VII of The Republic by Plato (380 BCE)*

**Socrates:** AND NOW, I SAID, let me show in a figure how far our nature is enlightened or unenlightened:—Behold! human beings living in an underground den [this is the cave], which has a mouth open towards the light and reaching all along the den; here they have been from their childhood, and have their legs and necks chained so that they cannot move, and can only see before them, being prevented by the chains from turning round their heads. Above and behind them a fire is blazing at a distance, and between the fire and the prisoners there is a raised way; and you will see, if you look, a low wall built along the way, like the screen which marionette [a type of puppet that is worked from above by strings] players have in front of them, over which they show the puppets.

**Glaucon:** I see.

**Socrates:** And do you see, I said, men passing along the wall carrying all sorts of vessels, and statues and figures of animals made of wood and stone and various materials, which appear over the wall? Some of them are talking, others silent.

**Glaucon:** You have shown me a strange image, and they are strange prisoners.

**Socrates:** Like ourselves and they see only their own shadows, or the shadows of one another, which the fire throws on the opposite wall of the cave?

**Glaucon:** True how could they see anything but the shadows if they were never allowed to move their heads?

**Socrates:** And of the objects which are being carried in like manner they would only see the shadows?

**Glaucon:** Yes.

**Socrates:** And if they were able to converse with one another, would they not suppose that they were naming what was actually before them?

**Glaucon:** Very true.

**Socrates:** And suppose further that the prison had an echo which came from the other side, would they not be sure to fancy when one of the passersby spoke that the voice which they heard came from the passing shadow?

**Glaucon:** No question.

**Socrates:** To them, the truth would be literally nothing but the shadows of the images.

**Glaucon:** That is certain.

**Socrates:** And now look again, and see what will naturally follow if the prisoners are released and disabused [corrected from their mistake error] of their error. At first, when

any of them is liberated and compelled suddenly to stand up and turn his neck round and walk and look towards the light, he will suffer sharp pains; the glare will distress him, and he will be unable to see the realities of which in his former state he had seen the shadows; and then conceive some one saying to him, that what he saw before was an illusion, but that now, when he is approaching nearer to being and his eye is turned towards more real existence, he has a clearer vision, what will be his reply?

And you may further imagine that his instructor is pointing to the objects as they pass and requiring him to name them, will he not be perplexed? Will he not fancy that the shadows which he formerly saw are truer than the objects which are now shown to him?

**Glaucon:** Far truer.

**Socrates:** And if he is compelled to look straight at the light, will he not have a pain in his eyes which will make him turn away to take and take in the objects of vision which he can see, and which he will conceive to be in reality clearer than the things which are now being shown to him?

**Glaucon:** True.

**Socrates:** And suppose once more, that he is reluctantly dragged up a steep and rugged ascent, and held fast until he's forced into the presence of the sun himself, is he not likely to be pained and irritated? When he approaches the light his eyes will be dazzled, and he will not be able to see anything at all of what are now called realities.

**Glaucon:** Not all in a moment.

**Socrates:** He will require to grow accustomed to the sight of the upper world. And first he will see the shadows best, next the reflections of men and other objects in the water, and then the objects themselves; then he will gaze upon the light of the moon and the stars and the spangled [sparkling] heaven; and he will see the sky and the stars by night better than the sun or the light of the sun by day?

**Glaucon:** Certainly.

**Socrates:** Last of he will be able to see the sun, and not mere reflections of him in the water, but he will see him in his own proper place, and not in another; and he will contemplate him as he is.

**Glaucon:** Certainly.

**Socrates:** He will then proceed to argue that this is he who gives the season and the years, and is the guardian of all that is in the visible world, and in a certain way the cause of all things which he and his fellows have been accustomed to behold?

**Glaucon:** Clearly he would first see the sun and then reason about him.

**Socrates:** And when he remembered his old habitation, and the wisdom of the den and his fellow prisoners, do you not suppose that he would felicitate himself on the change, and pity them?

**Glaucon:** Certainly, he would.

**Socrates:** And if they were in the habit of conferring honours among themselves on those who were quickest to observe the passing shadows and to remark which of them went before, and which followed after, and which were together; and who were therefore best

able to draw conclusions as to the future, do you think that he would care for such honours and glories, or envy the possessors of them? Would he not say with Homer [the famous Greek poet who Plato now quotes] “better to be the poor servant of a poor master. And to endure anything, rather than think as they do and live after their manner?”

**Glaucon:** Yes, I think that he would rather suffer anything than entertain these false notions and live in this miserable manner.

**Socrates:** Imagine once more, such an one coming suddenly out of the sun to be replaced in his old situation; would he not be certain to have his eyes full of darkness?

**Glaucon:** To be sure.

**Socrates:** And if there were a contest, and he had to compete in measuring the shadows with the prisoners who had never moved out of the den, while his sight was still weak, and before his eyes had become steady (and the time which would be needed to acquire this new habit of sight might be very considerable) would he not be ridiculous? Men would say of him that up he went and down he came without his eyes; and that it was better not even to think of ascending; and if any one tried to loose another and lead him up to the light, let them only catch the offender, and they would put him to death.

**Glaucon:** No question.

**Socrates:** This entire allegory, you may now append, dear Glaucon, to the previous argument; the prison house is the world of sight, the light of the fire is the sun, and you will not misapprehend me if you interpret the journey upwards to be the ascent of the soul into the intellectual world according to my poor belief, which, at your desire, I have expressed whether rightly or wrongly God knows. But, whether true or false, my opinion is that in the world of knowledge the idea of good appears last of all, and is seen only with an effort; and, when seen, is also inferred to be the universal author of all things beautiful and right, parent of light and of the lord of light in this visible world, and the immediate source of reason and truth in the intellectual; and that this is the power upon which he who would act rationally, either in public or private life must have his eye fixed.

**Glaucon:** I agree, as far as I am able to understand you.

## Question:

“It is better to be ignorant and comfortable than enlightened and in pain.”

Evaluate this view.

In your answer you should:

- make references to the text above;
- give reasoned arguments to support this statement;
- give reasoned arguments to support a different point of view; *and*
- reach a justified conclusion.



# HARROW SCHOOL

## 13+ Scholarship Science Examination 2024

Name (PRINT): .....

Section	Score
A	/ 16
B	/ 20
C	/ 22
D	/ 22
Total	/ 80
%	

### Instructions

- You have **2 hours** to answer all questions.
- Section A consists of 16 multiple choice questions. You must select the best answer, A-D, for each question and mark your answers on the separate Multiple Choice Answer Grid provided.
- Sections B, C and D should be answered on the examination paper.
- You should spend approximately 30 minutes on each section.
- Use blue or black ink for text.
- You may use a pencil and a ruler for diagrams.
- You may use a calculator.



# 13+ Scholarship Science Examination 2024

## Multiple Choice Answer Grid

Instructions:

- Write your name in the box provided.
- Use a pencil.
- Carefully shade the circle corresponding to your answer for each multiple choice question in the grid below.
- If you make a mistake, carefully erase the incorrectly shaded circle shade the correct one.

Name

ZIPGRADE.COM

1 (A) (B) (C) (D) 13 (A) (B) (C) (D)

2 (A) (B) (C) (D) 14 (A) (B) (C) (D)

3 (A) (B) (C) (D) 15 (A) (B) (C) (D)

4 (A) (B) (C) (D) 16 (A) (B) (C) (D)

5 (A) (B) (C) (D)

6 (A) (B) (C) (D)

7 (A) (B) (C) (D)

8 (A) (B) (C) (D)

9 (A) (B) (C) (D)

10 (A) (B) (C) (D)

11 (A) (B) (C) (D)

12 (A) (B) (C) (D)

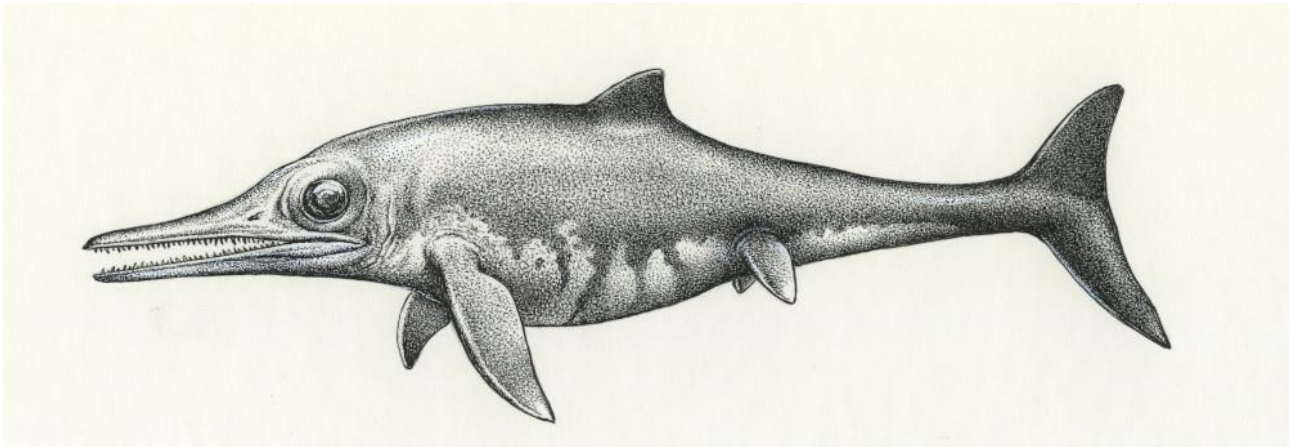
Science 13+ Scho... 202324 (9292)



## Section A: Multiple Choice

1. Which is not a kingdom of classification?

- A. vertebrates
- B. plants
- C. protists
- D. fungi



2. The picture above is of an ichthyosaur. They lived between 250 and 90 million years ago. They had scaly skin and breathed air. What type of animal were they?

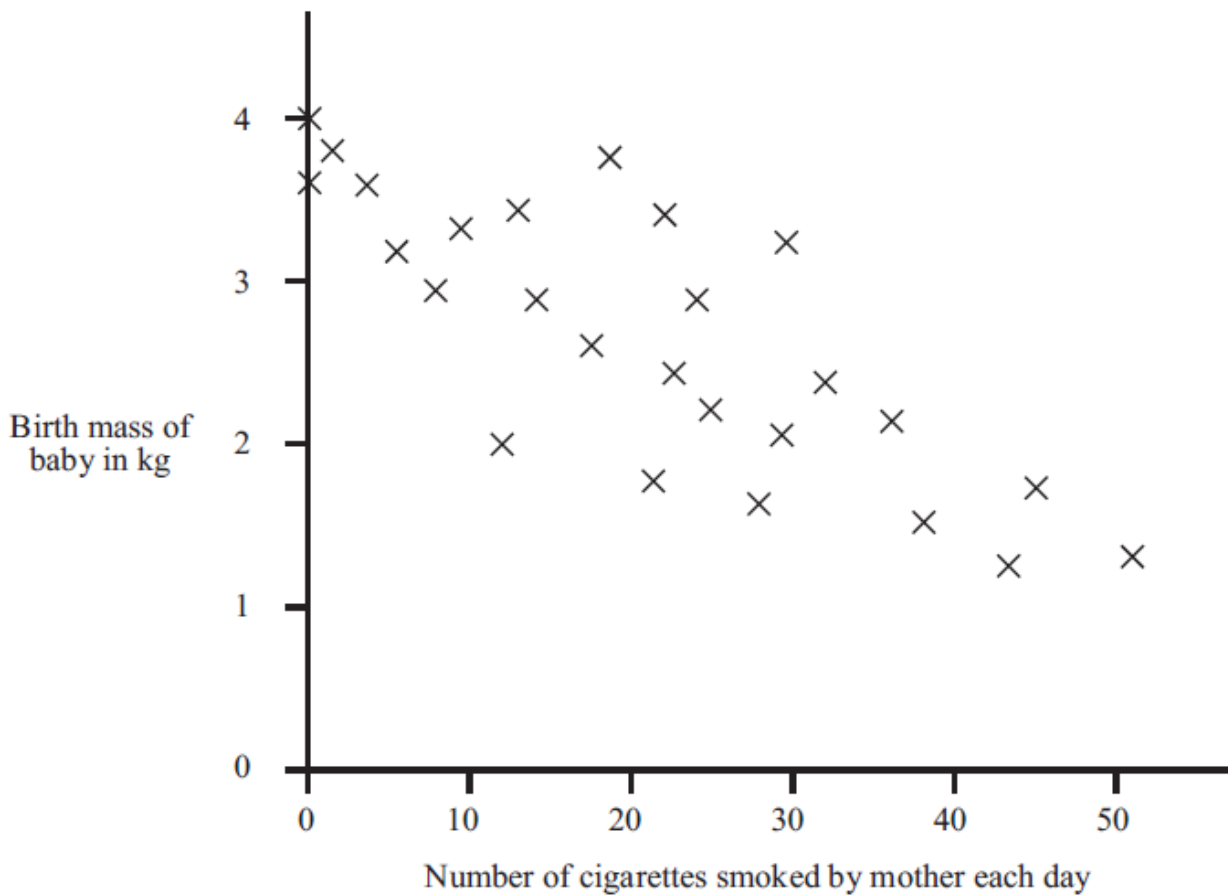
- A. fish
- B. reptile
- C. mammal
- D. amphibian

Questions **3** and **4** refer to the passage below:

*Hundreds of years ago, it was thought that the cure for a disease would be found where a person caught the disease. In 1760, The Reverend Edward Stone wondered whether a cure for a fever would be found in wet and boggy ground. One plant that grew there was the willow tree. He thought that willow trees would contain a cure for a fever. He ground up willow tree bark and gave it as a medicine to a person suffering from a fever. The person recovered.*

- 3.** Edward Stone's idea that the cure might be found in the bark of a willow tree is an example of...
- A.** a conclusion
  - B.** a hypothesis
  - C.** an investigation
  - D.** an evaluation
- 4.** He could not be sure that it was the willow bark that cured the fever because he did not...
- A.** repeat the experiment
  - B.** use a control
  - C.** know what chemicals were in the willow bark
  - D.** know what caused the fever

The graph below shows the effect of smoking during pregnancy on the birth masses of babies.



5. The graph indicates that...

- A. cigarette smoke contains nicotine
- B. the smoking of cigarettes during pregnancy always reduces the birth mass of babies
- C. the smoking of cigarettes during pregnancy has no effect on the birth mass of babies
- D. the smoking of cigarettes during pregnancy often leads to a lower birth mass of babies

Digitalis is a toxin that is extracted from a plant called a foxglove.

It can be used to treat patients who are likely to suffer from heart failure. It affects the rate of heartbeat and the volume of blood pumped per heartbeat.

The table below shows the effect of using different concentrations of digitalis on the heart of a male patient.

<b>Concentration of digitalis (arbitrary units)</b>	<b>Rate of heartbeat (beats per minute)</b>	<b>Volume of blood pumped per heartbeat (cm<sup>3</sup>)</b>
0	136	35
10	120	46
20	103	54
30	71	59
40	59	62
50	47	63

6. When 20 arbitrary units of digitalis were used on this patient, what was the volume of blood pumped by his heart?

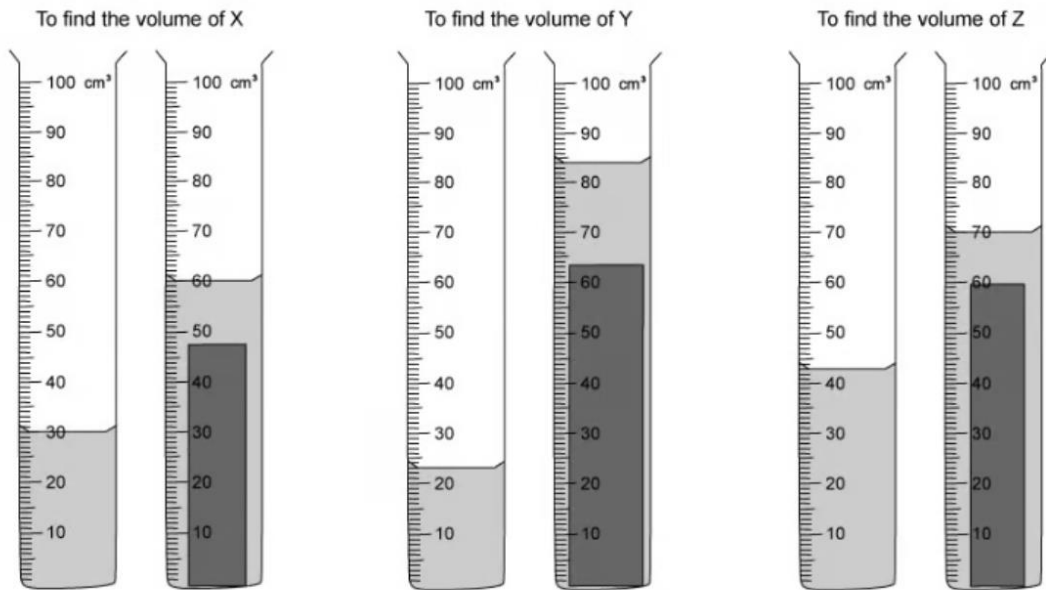
- A. 1.91 cm<sup>3</sup> per minute
- B. 5.15 cm<sup>3</sup> per minute
- C. 2060 cm<sup>3</sup> per minute
- D. 5562 cm<sup>3</sup> per minute

7. Which one of the following best describes the effect that increasing the dose of digitalis has on the activity of the heart?

	<b>Effect on heart rate</b>	<b>Effect on volume of blood pumped per beat</b>
<b>A.</b>	increase	Increase
<b>B.</b>	increase	decrease
<b>C.</b>	decrease	decrease
<b>D.</b>	decrease	increase

8.

Three blocks are placed into three measuring cylinders. These are shown below.



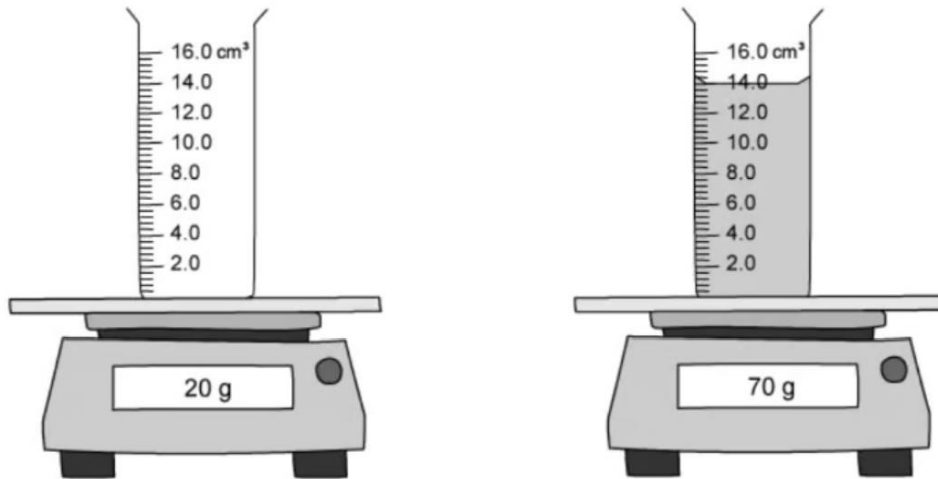
Which row in the table shows the blocks in order of increasing volume?

	Smallest volume	→	Largest volume
<b>A</b>	X	Y	Z
<b>B</b>	Y	X	Z
<b>C</b>	Z	Y	X
<b>D</b>	Z	X	Y

9.

The two diagrams below show a measuring cylinder.

In the diagram on the left, the measuring cylinder is empty. In the diagram on the right, the measuring cylinder contains a liquid.



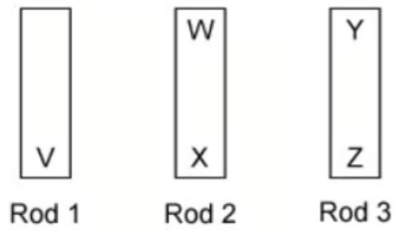
What is the density of the liquid?

- A.  $0.20 \text{ g/cm}^3$
- B.  $5.00 \text{ g/cm}^3$
- C.  $0.28 \text{ g/cm}^3$
- D.  $3.57 \text{ g/cm}^3$

**10.**

A student has a collection of metal bars that keep sticking to each other. She suspects that they might be magnets, so she runs a test.

She holds end V of rod 1, near to each end of the two other rods. The ends are shown in the diagram below.



Her results are as follows:

End V:

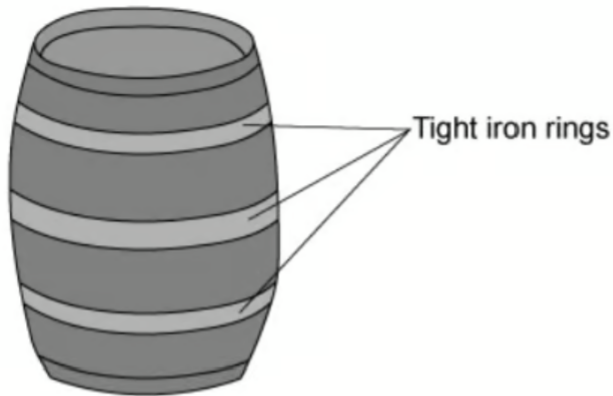
- Repels end W
- Attracts end X
- Attracts end Y
- Attracts end Z

Which of the metal rods is a magnet?

- A. 1 and 2
- B. 2 and 3
- C. 1 only
- D. 2 only

**11.**

Wooden barrels are often reinforced by putting tight iron rings around them.



What procedure would make it easier to get the iron ring onto the barrel?

- A. Heating the barrel.
- B. Cooling the iron ring.
- C. Soaking the barrel in water.
- D. Heating the iron ring.

**12.**

A crude method to measure the speed of sound involves banging two wooden blocks together to produce a sharp sound. One person bangs the blocks together. A second person uses a trundle wheel or tape measure to stand 100 m away. When the second person sees the blocks hit, they start the stopwatch. When they hear the bang, they stop the stopwatch.

Using this method a value of 420 m/s was measured for the speed of sound. The accepted value is 340 m/s.

The most likely reason for the difference between the measured and accepted value is:

- A. The time measurement is too short
- B. The time measurement is too long
- C. The distance measurement is too small
- D. The distance measurement is too big

**13.**

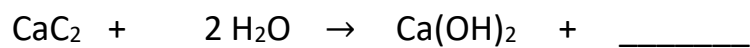
Universal indicator was added to a glass of lemon juice.  
The colour of the indicator turned:

- A. red
- B. green
- C. purple
- D. blue



**14.**

For the equation shown, predict the missing product.

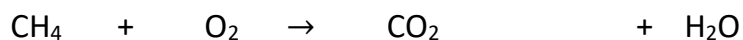


- A.  $\text{H}_2\text{O}$
- B.  $\text{CO}_2$
- C.  $\text{C(CH)}_2$
- D.  $\text{C}_2\text{H}_2$

15.

Methane is often reacted like this:

methane + oxygen → carbon dioxide + water



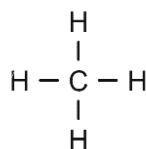
This reaction can be described as both:

- A. neutralisation & decomposition
- B. decomposition & redox (*reduction-oxidation*)
- C. decomposition & neutralisation
- D. combustion & redox (*reduction-oxidation*)

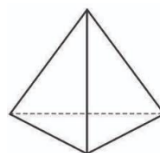
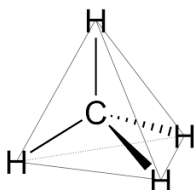
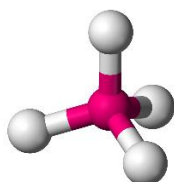
16.

Methane is the everyday name of carbon tetrahydride.

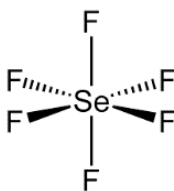
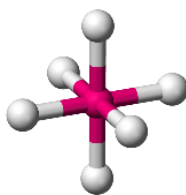
The CH<sub>4</sub> molecule consists of one carbon atom joined (bonded) to four hydrogen atoms.



Flat on paper, the 2D diagram looks like a square, but it is actually arranged as a pyramid. When the edges are joined, the shape has four faces; it is called “tetrahedral”.



What name do you think is given to the shape of molecules that have the shape of, SeF<sub>6</sub>?



- A. octahedral
- B. hexagonal
- C. bipyramidal
- D. spinningtopal

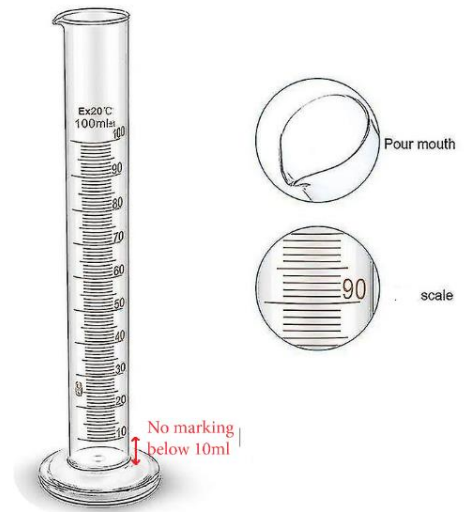
[Total: 16]

## Section B: Experimental Techniques

This page shows apparatus designed to measure volume.

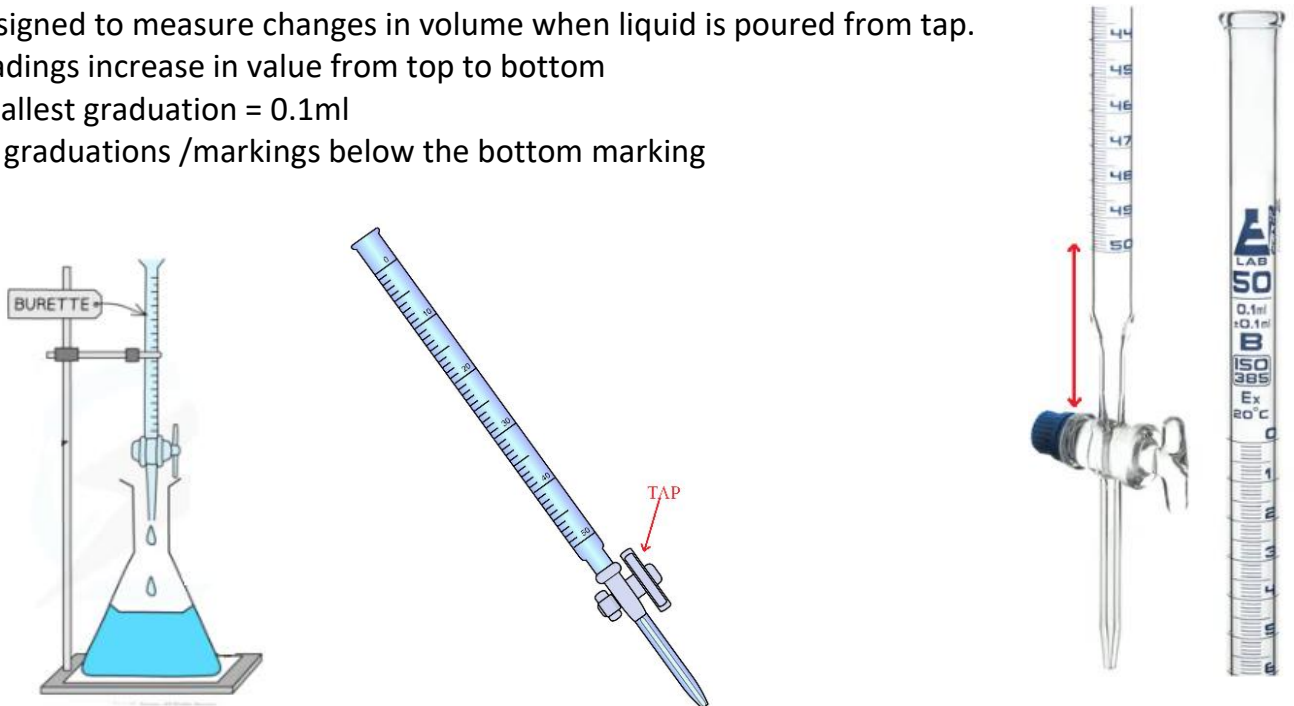
Measuring cylinder:

- designed to measure volume of liquid
- readings increase in value from bottom to top
- smallest graduation = 1ml
- no graduations /markings below the bottom marking



Burette:

- designed to measure changes in volume when liquid is poured from tap.
- readings increase in value from top to bottom
- smallest graduation = 0.1ml
- no graduations /markings below the bottom marking

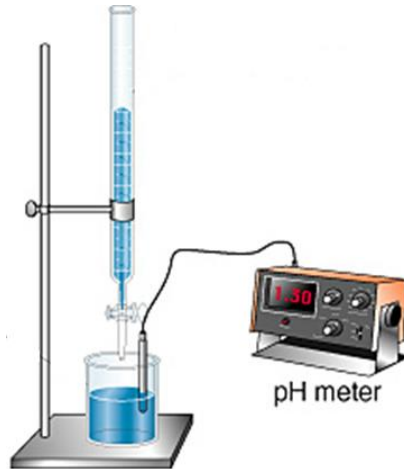


Gas syringe:

- designed to measure volume of gas
- smallest graduation = 1ml
- markings from zero to one hundred.



1. A student set up the burette as shown. An electronic pH meter is used to measure the exact pH value. This experiment can be used to accurately measure the volume of acid is needed to fully react with an alkali.



- a. This student used a beaker instead of a conical flask (as was shown in the diagram on the previous page). State & explain which you think is better for this experiment – the beaker or conical flask. **(1)**

.....

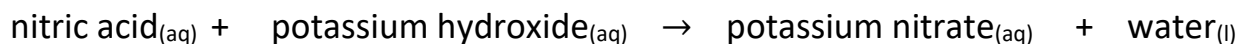
- b. A student started with 25ml of strong acid in the beaker. Suggest the reading on the pH meter. **(1)**

.....

- c. He then opened the burette tap, adding exactly 10ml of alkali from the burette into the flask. Suggest the new reading on the pH meter. **(1)**

.....

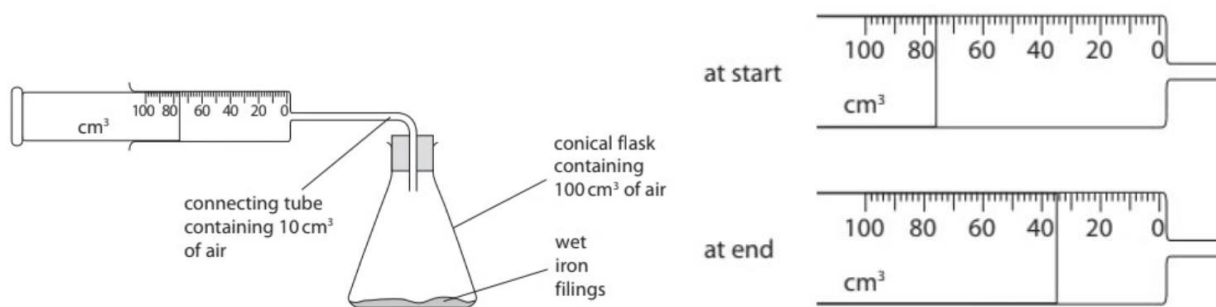
2. The word equation for the reaction that took place is:



Assuming the correct amount of acid & alkali when reacted, suggest the experimental method used to obtain a pure dry sample of the salt, potassium nitrate. You may wish to draw a labelled diagram to illustrate your answer.

(2)

A student sets up this apparatus to measure the volume of oxygen in a sample of air. An excess of wet iron filings is used. At the start of each experiment, the reading on the syringe is recorded and the apparatus is then left for a week so the reaction is complete then the syringe reading is recorded again.



3. Complete the table with the experimental readings.

syringe reading at start	76
syringe reading at end	
volume of oxygen used	

(1)

This table shows the results recorded by a different student.

volume of air in conical flask	100
volume of air in connecting tube	10
original volume of air in syringe	80
final volume of air in syringe	43

4. Calculate the percentage of oxygen in air using these results.  
Give your answer to 2 decimal places.

**(3)**

5. The table shows some possible causes of anomalous results in this experiment.

Complete the table using one of these terms: decreased, increased, or no effect

Possible Cause	Effect on volume of oxygen used
wet iron filings not in excess	
apparatus left for 1 hour instead of 1 week	
apparatus left in a warmer place for 1 week	

**(3)**

6. Consider only the measuring cylinder and burette. Both pieces of equipment are designed to measure liquids.
- a. Suggest why the measuring cylinder readings increase in value from bottom to top but the burette readings increase from top to bottom.

.....  
.....

**(1)**

- b. The burette provides a more accurate (precise) reading.  
Suggest one reason why.

.....

**(1)**

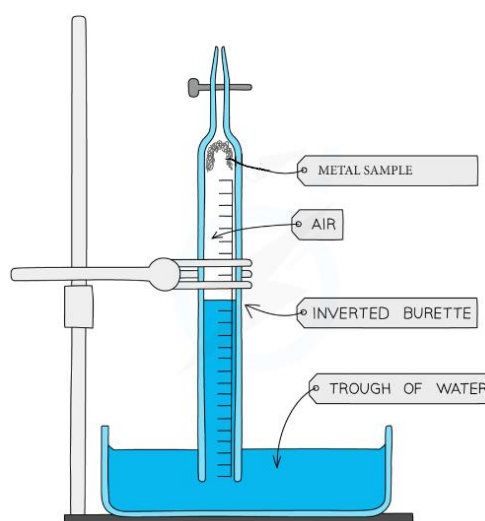
7. The highest recorded reading on the burette is 50ml.
- a. There are no markings between this last marking and the tap. Looking at the equipment, suggest why this is the case.

(1)

8. A student wanted to use the burette to investigate the reaction of a metal with air. To find out the volume between the last reading and the tap, he added water to this bottom part of the burette - only up to lowest mark, 50 ml. He then drained it into a small measuring cylinder & measured the volume as 3.8ml.

Experimental Method

- With the tap closed, place some iron filings into the bottom of the burette.
- Invert the burette into a trough of water; clamp it vertically.
- Record the initial water level reading.
- After 4 days record the new position of the water level



Burette readings:      final water level = 12.7 ml  
                                   initial water level = 2.6 ml

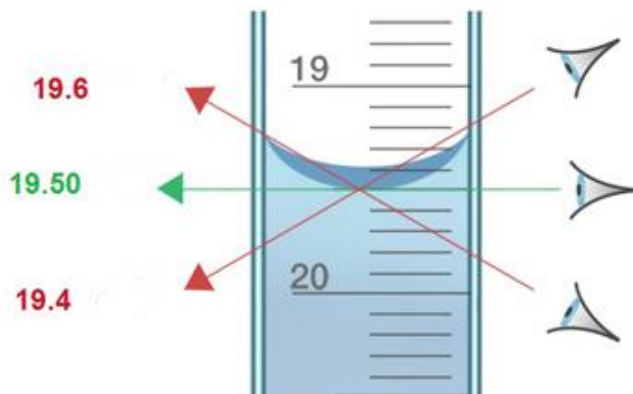
Data Processing

- a. The initial volume of air in the burette is 51.2ml.  
 Use the experimental values to show why.
- b. Determine the final volume of air in the burette, after the reaction.  
 Use this to calculate the volume of oxygen that reacted. Express this as a percentage.

(1)

(3)

9. Equipment must be used properly to prevent incorrect readings. The user's eye should be level with the bottom of the meniscus (the concave curve on the water surface) to avoid mistakes in the reading. The diagram shows a possible maximum (19.60ml) and minimum (19.40ml) in conjunction with the correct reading of exactly 19.50ml. This is referred to as a 'parallax error'.



a. Express the range of values from the maximum to minimum above & below as a percentage of the true reading.

**(1)**

b. Assuming this error has the same range for every reading from this burette, explain whether this error would have a smaller or larger influence on a smaller volume reading of 10ml.

.....

.....

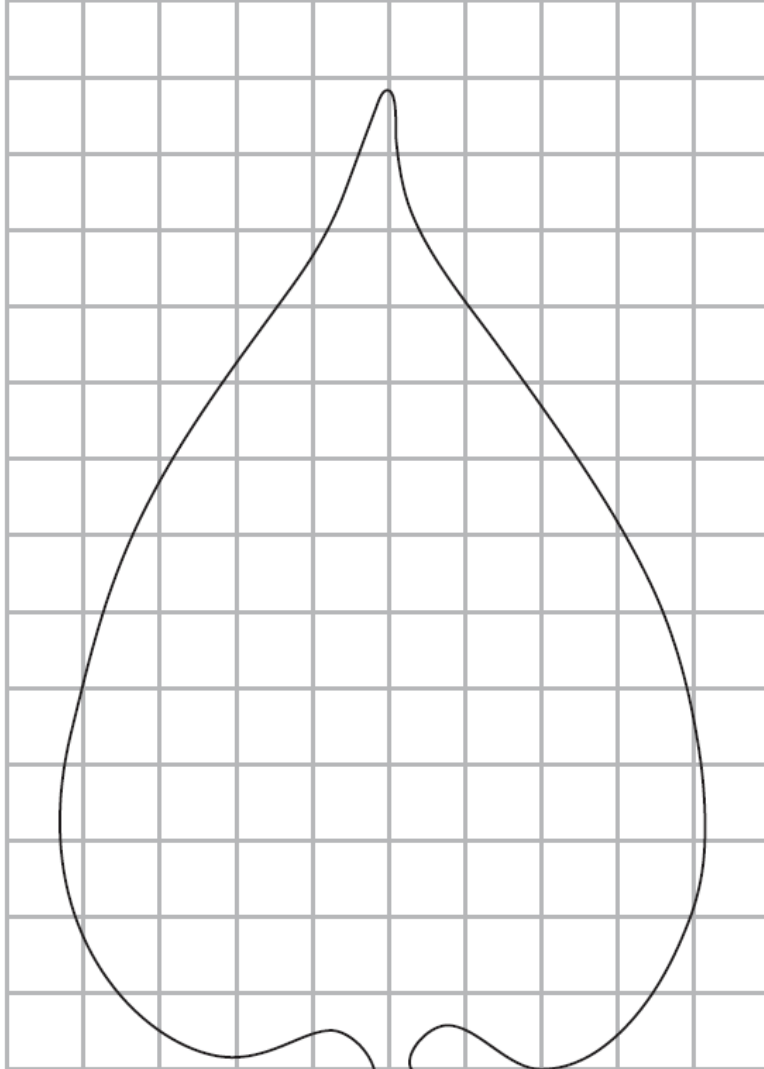
.....

**(2)**

**[Total: 22]**

## Section C: Data Analysis

A student wanted to estimate the surface area of a leaf so she drew an outline of the leaf on squared paper as shown below.



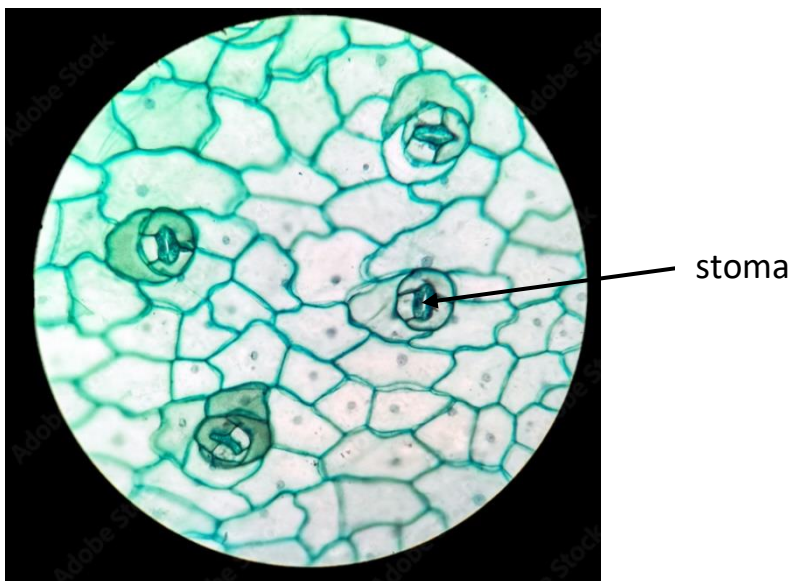
1. If each square is  $1 \text{ cm}^2$ , estimate the total surface area of the leaf.

(2)

.....  $\text{cm}^2$

On the underside of the leaf there are small pores (holes) known as stomata (singular = stoma) which can open and close.

The circular image below shows the view down a light microscope of the underside of a leaf.



2. If the diameter of the circular image is 0.5mm, calculate its area to two significant figures. Show your working. **(2)**

..... mm<sup>2</sup>

3. Using your answer in Question 2., calculate the number of stomata per mm<sup>2</sup> on the underside of the leaf. **(2)**

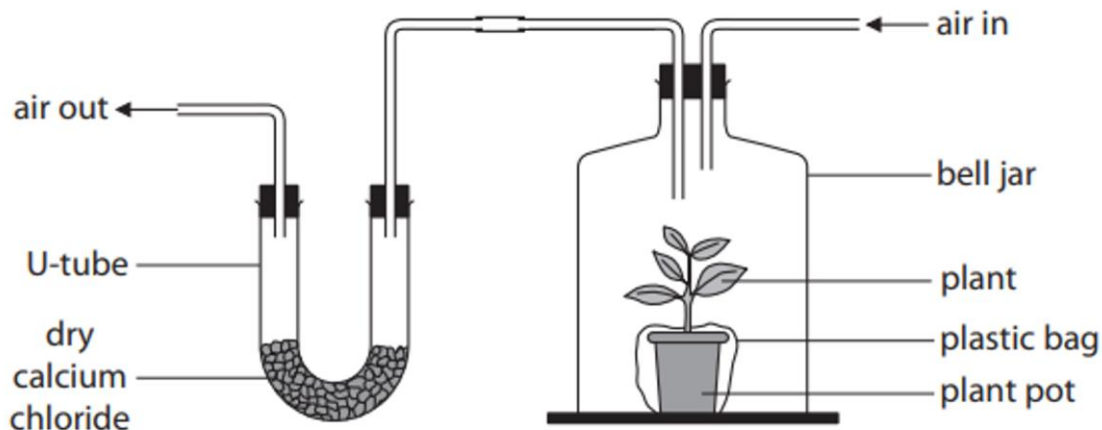
..... stomata per mm<sup>2</sup>

4. Describe how you could improve the reliability of your answer. **(1)**

.....  
.....

Leaves lose water vapour through their stomata in a process known as transpiration.

An investigation was carried out to measure water loss by transpiration from a plant at different temperatures using the apparatus shown below.



The calcium chloride absorbs the water lost by transpiration.

5. Explain why a plastic bag was placed around the plant pot during the investigation. (2)

.....

.....

.....

The table below shows the results of the investigation.

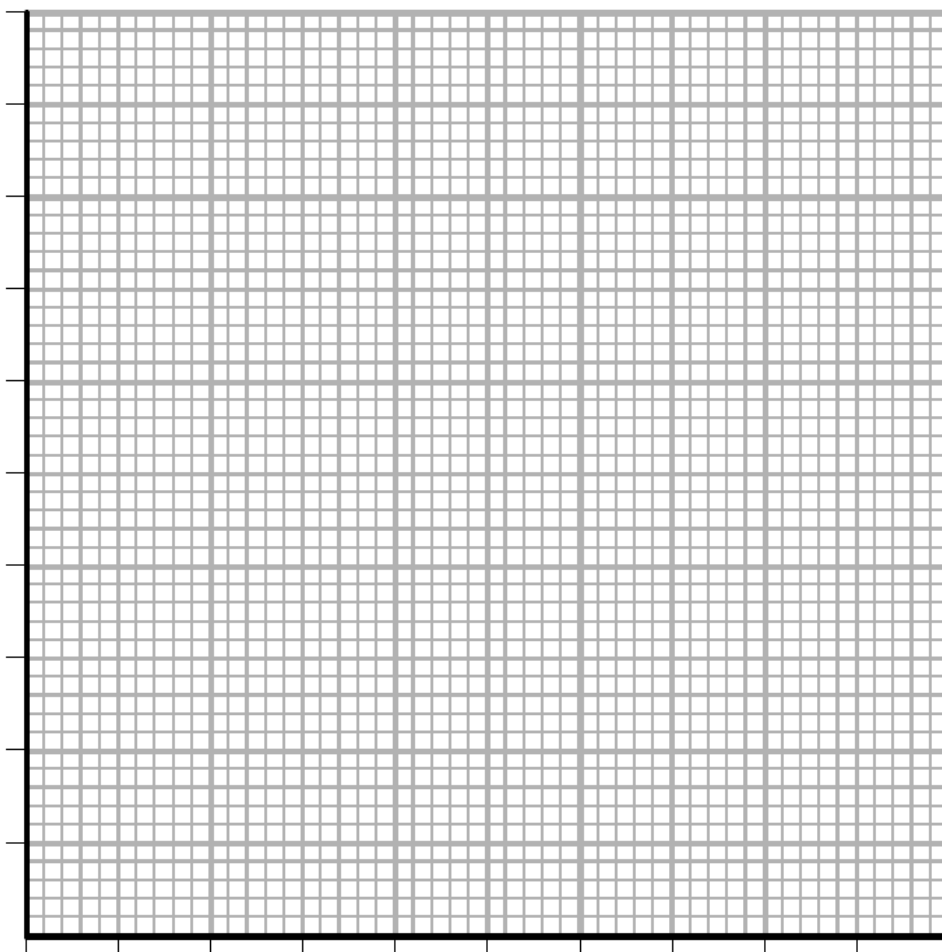
Temperature / °C	Mass of calcium chloride / g		Mass of water lost / g
	Before investigation	After investigation	
5	80	82	2
15	80	87	
25	80	94	
35	80	102	
45	80	99	

6. Calculate the mass of water lost from the plant at each temperature and enter the values in the table. The first has been done for you. (1)

7. State one condition that would need to be controlled during this investigation for the results to be comparable. **(1)**

.....

8. Plot a line graph of mass of water lost against temperature on the grid below. Use a ruler to join the points with straight lines. **(5)**



9. Calculate the percentage increase in the mass of water lost between 5°C and 35°C. Show your working. **(2)**

..... %

**10.** Suggest a reason for this increase in the mass of water lost between 5°C and 35°C. **(1)**

.....  
.....

**11.** Suggest a reason for the result at 45°C. **(1)**

.....  
.....

**[Total: 20]**

## Section D: Comprehension

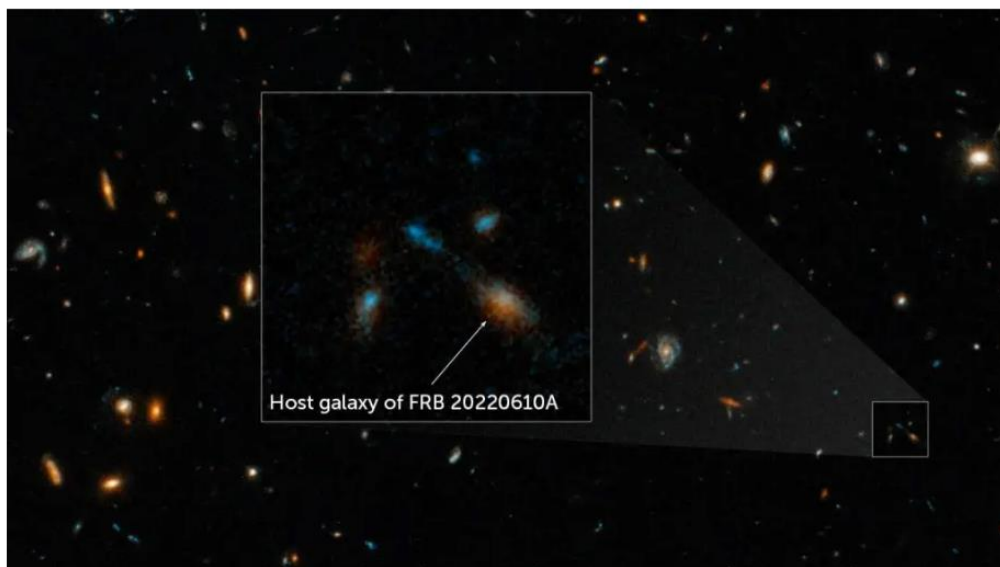
Read the following article and use it to help answer the questions relating to it that follow.

An unbelievably strong spurt of electromagnetic energy has for the first time been traced back to a cluster of seven merging galaxies. The finding could support the hypothesis that such mysterious signals, known as fast radio bursts, originate from magnetars, types of neutron stars with extremely powerful magnetic fields. The magnetic effects of these stars are so strong that if a magnetar were located halfway between Earth and the Moon, it would erase the magnetic strip on everyone's credit card in the world.

Fast radio bursts, or FRBs, are fleeting explosive events: They last fractions of a second but release as much energy as the Sun does in a month. It remains unclear what causes these strange spectacles, first discovered in 2007.

"We think they're caused by some kind of very compact object, like a magnetar," Alexa Gordon, an astronomer at Northwestern University in the US, said during a news conference at the American Astronomical Society's annual meeting on January 9<sup>th</sup>. Researchers previously spotted a magnetar in our galaxy producing an FRB, though nobody has shown that all such bursts can be attributed to magnetars.

Using NASA's Hubble Space Telescope, Gordon and her colleagues took a closer look at where FRB 20220610A, the most powerful and distant FRB discovered to date, came from. The team was surprised to find a collection of seven galaxies located 8 billion light-years from Earth, all crammed inside a region the size of the Milky Way.



A Hubble Space Telescope image of the host galaxy of an exceptionally powerful fast radio burst, FRB 20220610A. Image by NASA, ESA, STScI and Alexa Gordon (Northwestern)

FRBs have been traced back to all sorts of environments, including lone galaxies and globular clusters. But this was the first seen emerging from a seven-galaxy pileup, the team reported at the news conference and in a paper released in November.

Such chaotic environments can lead to galaxies swapping gas, dust and other material, triggering the birth of new stars. If a massive star formed under these conditions, its death could have left behind a magnetar, potentially explaining the FRB. The team hopes to use the James Webb Space Telescope to probe the seven-galaxy system in detail to look for evidence of a magnetar.

Adapted from a Science News article by Adam Mann

Some of the numbers involved in this article are very large in terms of the everyday units that we use to describe things such as metres (m), seconds (s) and kilograms (kg). To deal with this we can use extra ‘prefixes’ (that is, extra names or symbols in front of the units) to describe the numbers involved.

You may have come across some of these before. For example, ‘kilo’ meaning thousand, so 1 kilogram = 1 thousand grams (1 kg = 1,000 g) or 1 kilometre = 1 thousand metres (1 km = 1,000 m).

Here is a table with some such prefixes and their meanings which may be needed in answering some of the questions below.

Name	Symbol	Meaning
kilo	k	1,000 (1 thousand)
mega	M	1,000,000 (1 million = 1 thousand thousand)
giga	G	1,000,000,000 (1 billion = thousand million)
yotta	Y	1,000,000,000,000,000,000,000,000 (1 million billion billion)
quetta	Q	1,000,000,000,000,000,000,000,000,000,000 (1 million million billion billion or 1 thousand billion billion billion)

Questions:

1. What is a magnetar?

**(1)**

.....

2. What do the letters FRB stand for?

(1)

.....

3. A 'light-year' is the distance that light travels in one year.

a. Write-down the formula that connects speed, distance and time.

(1)

.....

b.

i. Show that there are approximately 32 million seconds in one year.

(1)

.....

.....

ii. The speed of light is 300 Mm/s. Using the value of 32 million seconds for one year, calculate how large 1 light-year is in Mm. Show your reasoning carefully and clearly.

(3)

.....

.....

.....

iii. Using the information in the table near the top of the question, how many km are there in a Mm?

(1)

.....

iv. Use words such as 'thousand', 'million', and 'billion' to express the distance of one light year in kilometres. You may find some of the information in the table helpful for this.

(1)

.....

4. How far from Earth did FRB 20220610A originate?

a. In light-years

(1)

.....

b. In km. Express your answer using words such as ‘thousand’, ‘million’ and ‘billion’ again.

(1)

.....

5. Galaxies are collections of around 100 billion stars. According to the article, how would the density of the region from which FRB 20220610A originates compare with the density of the Milky Way. Explain your reasoning carefully.

(2)

.....

.....

6. The article says that FRBs release as much energy as the Sun does in a month.  
a. How many days are there in a month, on average? Show how you obtain your answer.

(2)

.....

.....

b. Based on your answer to a. above, how many seconds are there in a month, on average? Show how you obtain your answer.

(2)

.....

.....

7. In order to understand how energetic FRBs are, we need to know a quantity about the Sun, called its *power*. The *power* of the Sun is the rate at which it releases energy. The power of the Sun can be measured in yottawatts (W), where 1 yottawatt means an energy of 1 yottajoule is being released every second. (1 YW = 1 YJ/s). The power of the Sun in these terms is 380 YW.

The equation relating power and energy is

$$\text{power} = \frac{\text{energy released}}{\text{time taken}}$$

a. Use your answer to 6b (or otherwise) to calculate the amount of energy released by an FRB. Show how you obtain your answer and give it in units of quettajoules (QJ).

**(3)**

.....  
.....  
.....

b. The article indicates that fast radio bursts last for fractions of a second. If FRB 20220610A lasted for 1 millisecond (one thousandth of a second) calculate its power. Show your reasoning and include appropriate units with your answer.

**(2)**

.....  
.....

**[Total: 22]**