SYDNEY BOYS HIGH SCHOOL

Year 10 Yearly Science Exam

2022

Topics to be examined:

- Biotechnology and Evolution
- Universe

Time: 60 min.

PART A	Knowledge MC	10 marks
PART B	Process MC	10 marks
PART C	Skills ER	20 marks
	Total	40 marks

Write your **name and class** on **all sections** of this paper.

PART A: Knowledge Multiple Choice - 10 marks

Answer All Questions on the Multiple Choice Answer Sheet provided.

1. According to Lamarck's 'theory of inheritance of acquired characteristics', what would happen if a cat lost an eye in an accident as a kitten?
   - **a)** The cat would have kittens with one eye.
   - **b)** The cat would lose sight in the other eye
   - **c)** The cat's eye will grow back.
   - **d)** The cat would have kittens with two eyes.

2. Which statement most correctly contrasts natural selection and artificial selection?
   - **a)** natural selection can occur in a short time while artificial selection takes many generations
   - **b)** both processes can eventually result in the formation of new species
   - **c)** natural selection can occur without human involvement, while artificial selection cannot
   - **d)** both processes require variation and competition within the species

3. The fossil record shows that Coelacanth organisms have survived almost unchanged for millions of years. Based on Darwin's theory of evolution, which statement provides the best reason for the minimal change of Coelacanth organisms over time?
   - **a)** Environmental conditions for Coelacanths have not changed dramatically.
   - **b)** Humans protected the Coelacanths with conservation and breeding programs.
   - **c)** Natural selection of predators has kept Coelacanths unchanged
   - **d)** The population of Coelacanths has always stayed small, due to a lack of food.

4. Which of the following provides the best evidence that present-day organisms evolved from organisms in the past, through a process of gradual change?
   - **a)** Gorillas and humans have some similar behaviours.
   - **b)** The Galapagos Islands are inhabited by a large number of reptile species.
   - **c)** The limbs of many different vertebrate species have a common basic structure.
   - **d)** Each continent has different animal and plant species.

5. Which of the following statements is incorrect?
- **a)** Mutations may give an individual an advantage in a population.
- **b)** Natural selection does not change the frequency of neutral mutations in a population.
- **c)** Mutations always cause cancer.
- **d)** Some mutations are lethal.

6. Which of the following statements concerning reproductive isolation and geographic isolation of two populations is correct?
- **a)** Reproductive isolation of two populations always occurs before their geographic isolation.
- **b)** Two populations that are geographically isolated must be two different species.
- **c)** Subspecies form when two populations are reproductively isolated.
- **d)** Speciation occurs when two populations become reproductively isolated.

7. A super nova is:
- **a)** a group of stars
- **b)** an exploding star
- **c)** a fixed pattern of stars
- **d)** a cloud of dust and gas.

8. When a telescope is constructed using two biconvex lenses and an adjustable dark tube, the image of the object viewed will be:
- **a)** enlarged, inverted
- **b)** reduced, upright
- **c)** same size, inverted
- **d)** same size, upright

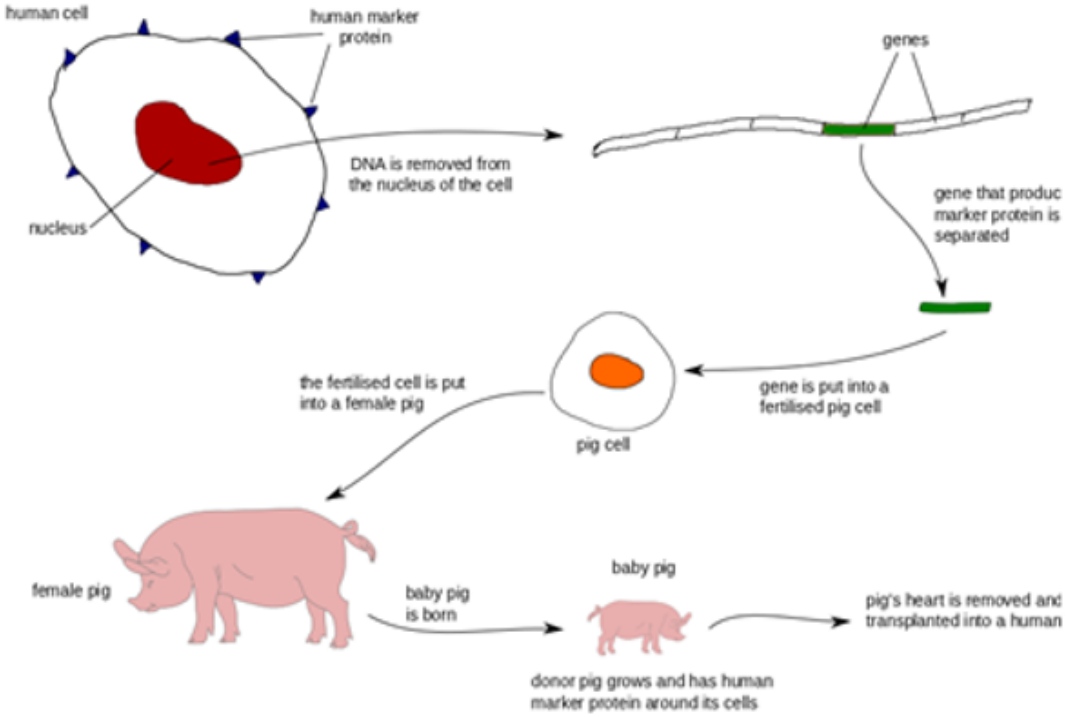
9. Which statement about the Big Bang Theory is incorrect?
- **a)** it is the concept that there was a moment when time and space were created
- **b)** the universe was formed from a very small dense star which exploded
- **c)** the conversion of energy into matter resulted in the formation of atomic particles
- **d)** the universe has continued to expand and cool since that event

10. How bright a star appears from the Earth is called:
- **a)** electromagnetic radiation
- **b)** apparent magnitude
- **c)** absolute magnitude
- **d)** stellar parallax

PART B: Process Skills Multiple Choice - 10 marks

Answer All Questions on the Multiple Choice Answer Sheet provided.

11. Scientists are experimenting with ways to enable pigs to develop organs that are suitable for transplant into humans. The procedure is shown below.



The diagram indicates the in order for the heart from a pig to be transplanted into a human.

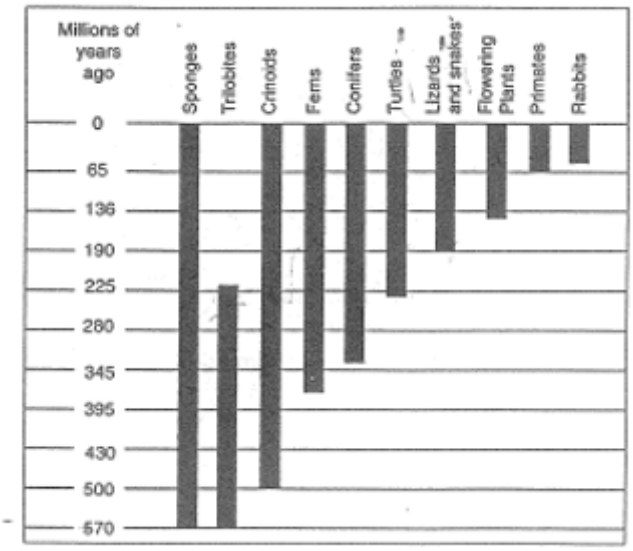
Select the correct statement:

a) the nucleus of a human cell must be put into a pig cell
b) the heart of a donor pig must grow until it is the same size as a human heart
c) marker protein needs be put into a fertilised pig cell
d) the donor pig must have a specific protein on the outside of its cell

12. The most primitive frogs in the world live in New Zealand.
Their feet do not have webbing between the toes.
The young frogs develop from eggs inside a thick jelly-like capsule.
They do not have a swimming tadpole stage.
From this information, the best conclusion is that these frogs:

a) are more advanced than most frogs
b) are not related to modern frogs
c) will soon become extinct
d) can live and breed away from water

The Diagram below shows when different organisms lived on the Earth.



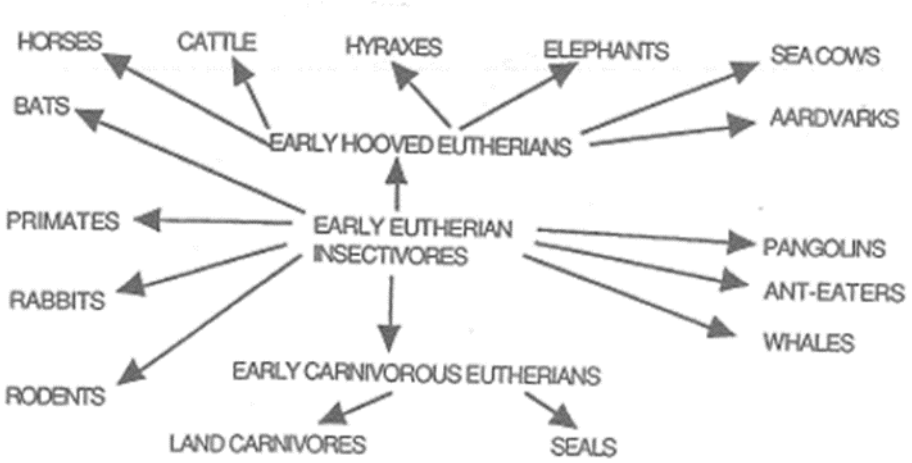
13. The fossil of a turtle was found in the same rock layer as a fossil of a snake.
Scientists could reasonably conclude that the rock layer was between:

a) 190 and 225 million years old
b) 0 and 190 million years old
c) 136 and 190 million years old
d) 65 and 225 million years old

14. A scientist believed that a rock layer was 225 million years old.
The presence of which types of fossils in this rock most strongly supports this belief?

a) trilobites and turtles
b) conifers and ferns
c) trilobites and crinoids
d) sponges and conifers

15. Possible Development of Mammals



According to the above diagram:

a) seals are land carnivores
b) horses are more closely related to pangolins than to hyraxes
c) aardvarks are hooved insectivores
d) ancestors of rabbits once ate insects

16. The Darwin/Wallace theory of evolution proposes that organisms have evolved from common ancestors. Closely related organisms have more DNA in common than those less closely related.

The table shows the percentage similarity in the DNA of 5 species: P, Q, R, S and T.

	P	***Q***	***R***	***S***	***T***
P	–	69	93	86	91
Q	69	–	92	84	88
R	93	92	–	80	77
S	86	84	80	–	95
T	91	88	77	95	–

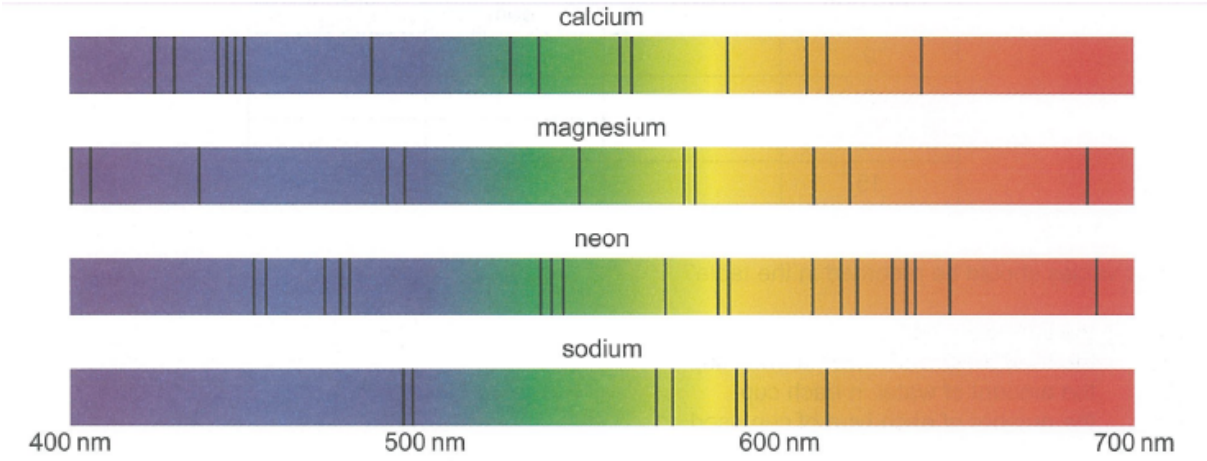
Which organism is most closely related to P?

a) Q
b) R
c) S
d) T

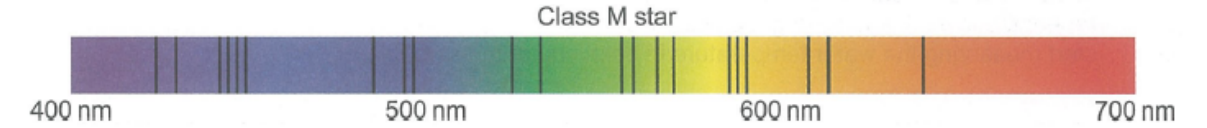
17. White light is a mixture of light waves of different wavelengths. It can be separated to form a spectrum of all the colours of light.

An absorption spectrum is produced when white light passes through a gas. Atoms of each element in the gas absorb light of a unique set of wavelengths, forming dark lines in the spectrum.

The diagrams show the absorption spectra of four different elements.



The absorption spectrum from a star can be used to identify the elements in the star's outer layers. This is the absorption spectrum from a Class M star.



Which two elements are found in the star's outer layers?

a) calcium and neon

b) calcium and sodium

c) magnesium and neon

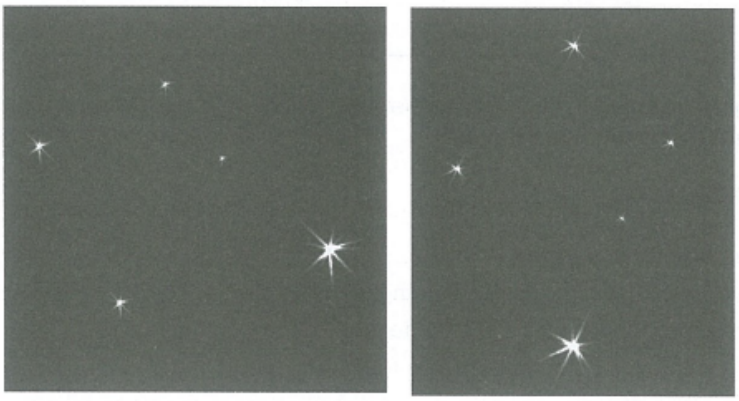
d) magnesium and sodium

18.

The South Celestial Pole (SCP) is an imaginary point in the sky directly above the South Pole. The stars appear to move clockwise in a circle around the SCP, completing one revolution in 24 hours.

The photographs show the group of stars called the Southern Cross at a particular time at night.

Photo 1 **Photo 2**



How many hours after photo 1 was taken would the Southern Cross be in the same orientation as it is in photo 2?

a) 17
b) 12
c) 5
d) 3

19.

Distances in space are so large that astronomers use special units to record them. One of these is the astronomical unit (AU). One astronomical unit is equal to the average distance between Earth and the Sun.

The table below shows the distance between the Sun and several objects in the Solar System.

Object	Average Distance from Sun (km)
Mercury	58 000 000
Earth	150 000 000
Asteroid belt	450 000 000
Neptune	4 500 000 000
Kuiper belt	6 000 000 000
Oort cloud	9 000 000 000 000

What is the average distance between the Sun and the Kuiper belt, in astronomical units?

a) 6
b) 40
c) 600
d) 5 850 000 000

20.

The gravitational attraction of a planet depends on a number of factors.

This table shows information about some of the planets in our Solar System.

	Mercury	Venus	Earth	Mars	Saturn	Uranus
Mass (10^{24} kg)	0.330	4.87	5.97	0.642	568	86.8
Diameter (km)	4879	12104	12756	6794	120536	51118
Acceleration due to gravity (m/s^2)	3.7	8.9	9.8	3.7	9.0	8.7

Comparing the data for which two planets **CANNOT** be used to show that the gravitational attraction of a planet depends on more than just the mass of the planet?

a) mercury and mars

b) venus and saturn

c) venus and earth

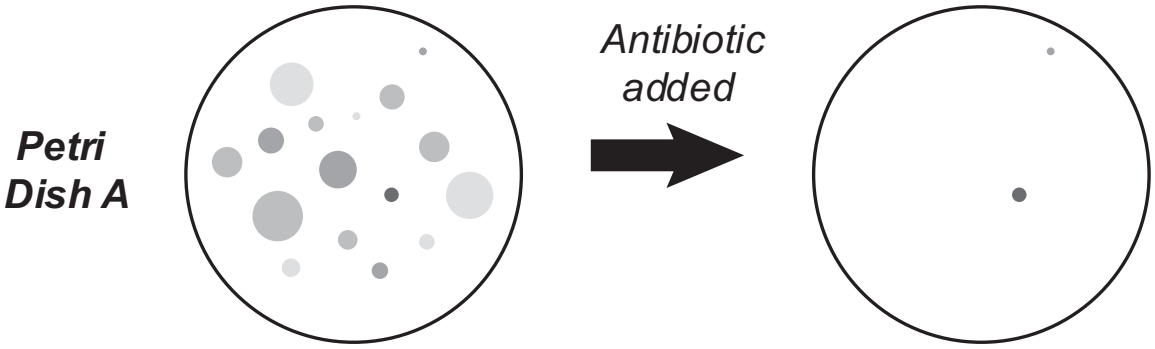
d) saturn and uranus

Part C – 20 marks

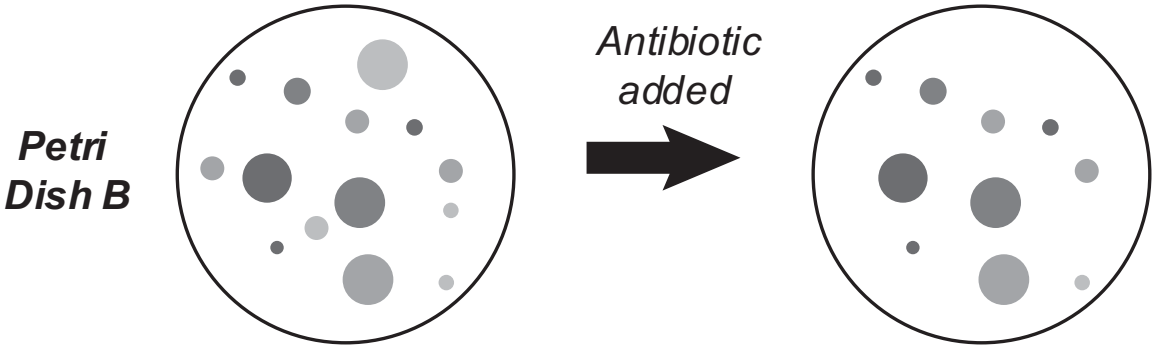
Question 1 (3 marks)

Antibiotic resistance is an increasingly problematic phenomenon due to the widespread use of antibiotics in medicine and industry. An experiment was performed to model the rise of antibiotic resistant bacteria.

A wild population of single celled bacteria is cultured in a petri dish (*Petri Dish A*) containing nutrient agar to create visible colonies. An antibiotic is added to this petri dish and allowed to incubate for 24hrs. Most colonies of bacteria are killed, with only a few surviving.



The surviving colonies are cultured onto a new sterile petri dish (*Petri Dish B*) with nutrient agar to create new colonies. The same antibiotic is added and allowed to incubate again for 24hrs. The result is shown the diagram below.



(Question continues on next page)

With reference to appropriate scientific theories and mechanisms, explain the result of this experiment. **3**

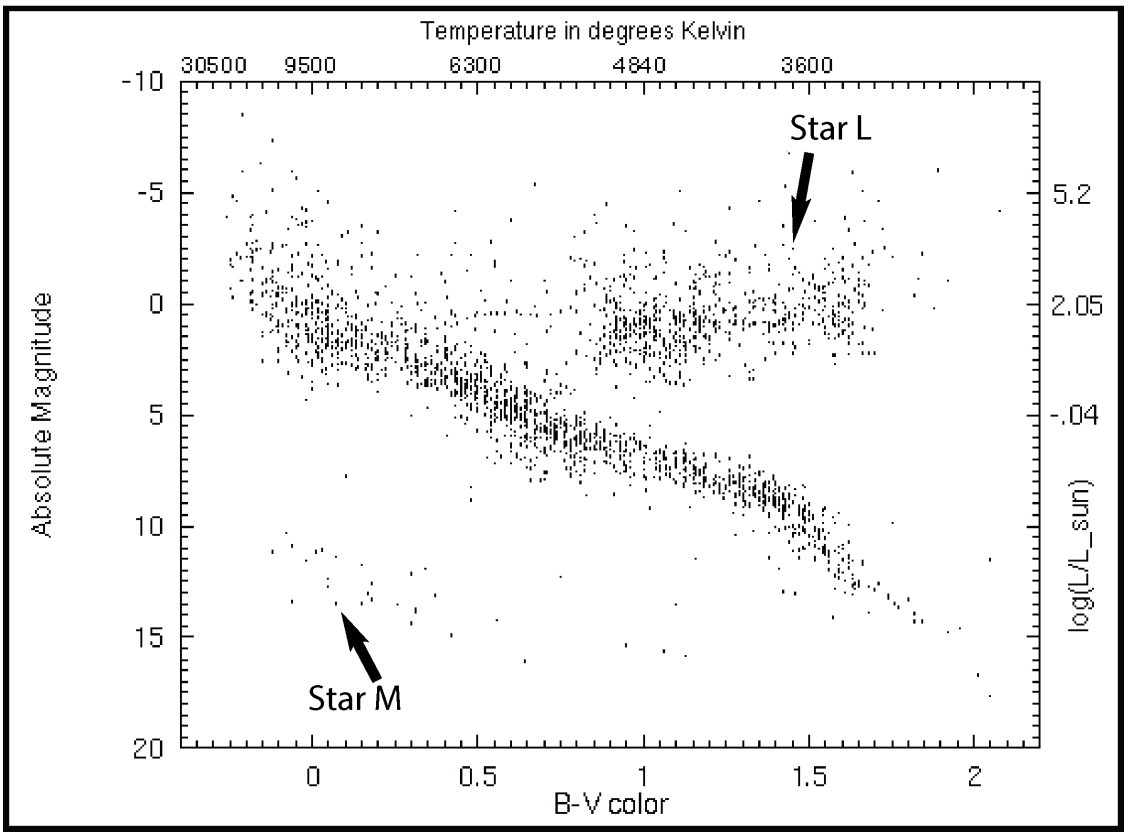
Question 2 (2 marks)

Genetic engineering is a technology that is increasingly being used today in agriculture, industry, and medicine.

Explain the role of *restriction enzymes* and *DNA Ligases* in modifying the genetic makeup of an organism **2**

Question 3 **(5 marks)**

A *HR Diagram* is used to classify the different types of stars observed in the universe.



a) By using the HR diagram, identify the type of star *L* and *M* are. **2**

b) Qualitatively compare the surface temperature, luminosity, and nuclear processes of stars *L* and *M* **3**

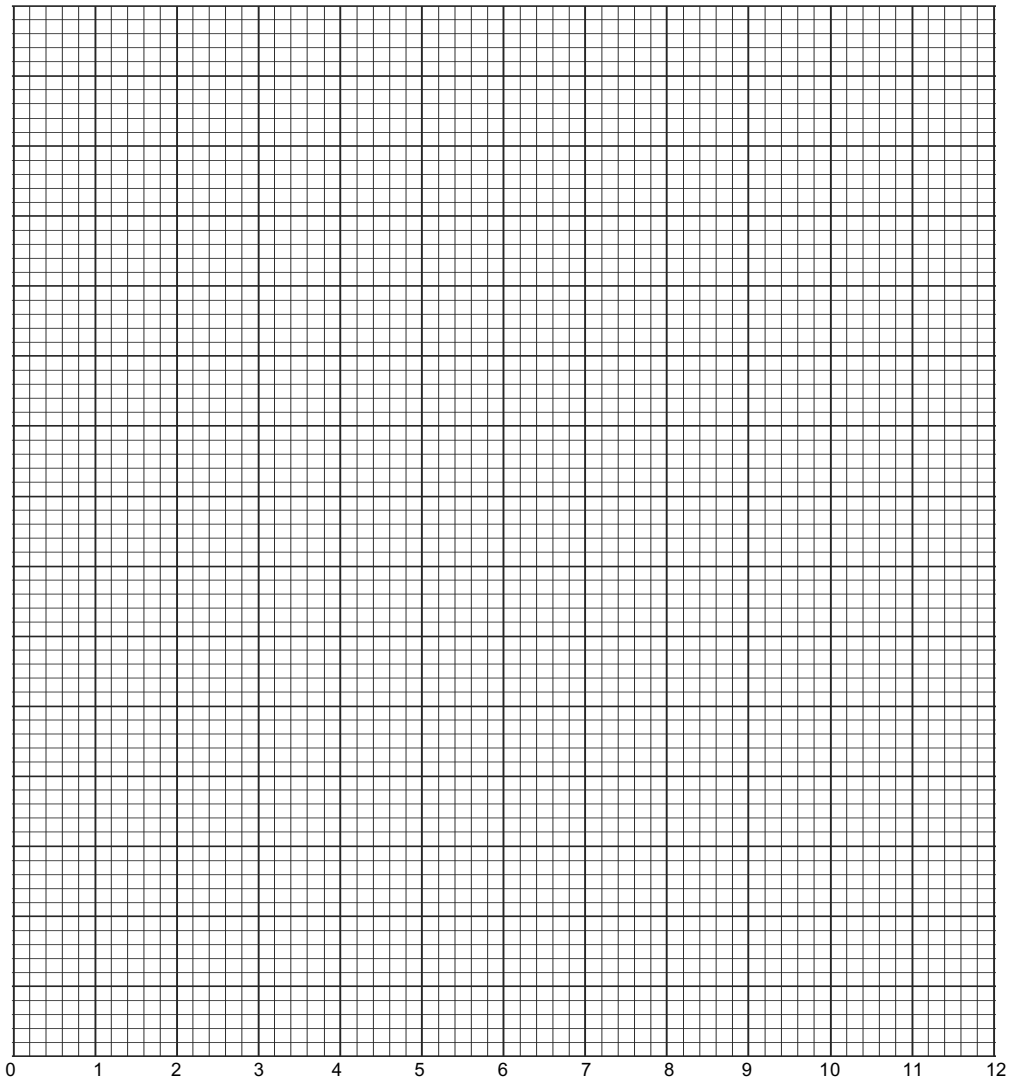
Question 4 (10 marks)

Cepheid variable stars are stars whose absolute luminosity oscillates with a regular period. In 1912, astronomer Henrietta Leavitt discovered a relationship between the period of these stars and their absolute luminosity (how bright they are).

A nearby star cluster was discovered to contain several Cepheid Variable stars.
Plot a graph of the data in the following table.

Star	***Period (days)***	***Average Absolute Magnitude***
A	1.84	4.79
B	2.13	5.45
C	2.81	6.63
D	3.80	3.43
E	3.10	3.28
F	4.64	4.43
G	5.67	1.19
H	6.64	-0.97
I	7.01	-0.41
J	8.64	-2.36
K	9.87	-3.85
L	9.66	-4.59

a) Graph the data provided in the table on the grid below **5**



b) Showing all working, **use your graph** to calculate the gradient of the LOBF and the *y-intercept* **2**

c) The periods of two distant stars *X* and *Y* are measured to be 6.25 days and 1.31 days respectively. From your graph, determine the average absolute magnitude of these stars **2**

d) As viewed from earth, stars X and Y have the same apparent brightness. From the data above, determine which star is closer to the earth **1**

END OF EXAM

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2022

Marking Scheme (Criteria, Sample Answers and Markers Notes).

PART A	Knowledge MC	10 marks
PART B	Process Skills MC	10 marks
PART C	Skills Extended Response	20 marks
	Total	40 marks

PART A: Multiple Choice - 20 marks

Q	1	2	3	4	5	6	7	8	9	10
A	A	C	A	C	C	D	B	A	B	B

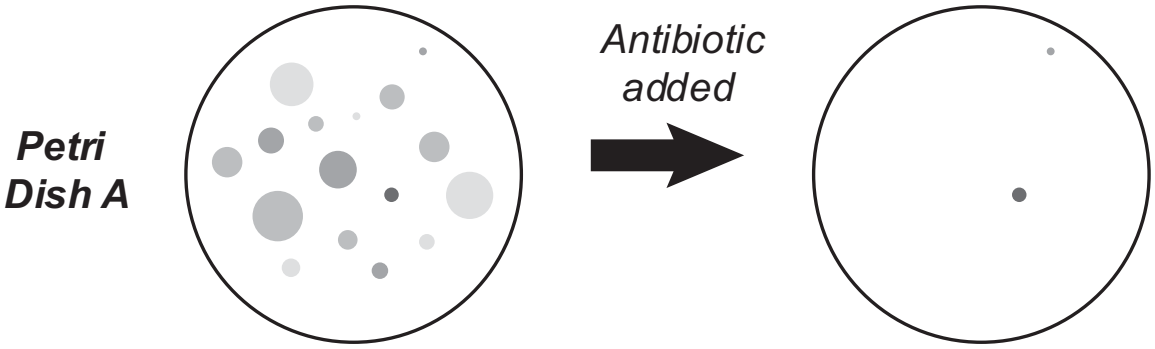
Q	11	12	13	14	15	16	17	18	19	20
A	D	D	B	A	D	B	B	C	B	C

Part B

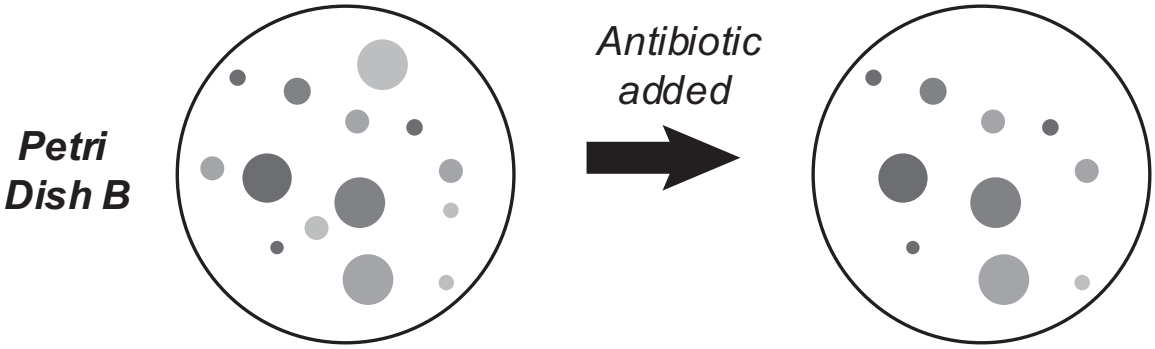
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The surviving colonies are cultured onto a new sterile petri dish (*Petri Dish B*) with nutrient agar to create new colonies. The same antibiotic is added and allowed to incubate again for 24hrs. The result is shown the diagram below.



(Question continues on next page)

Q1. With reference to appropriate scientific theories, explain the result of this experiment. **3**

Criteria	Marks
Thoroughly Explains the result by specifically referring to the mechanisms of evolutionary processes including: - **Variation** of traits within a population exists through **mutation** which produces **new alleles** which are inherited. - **Antibiotic** acts as a **Selection Agent** . - Individuals with traits best suited for survival (fittest), survive and reproduce more often, increasing **allele frequency** of the **favourable trait** (**antibiotic resistance**).	3
Attempts to Explain the result by referring to some aspects of mechanisms of evolution including: - **Variation** of traits within a population exists through **mutation** which produces **new alleles** which are inherited. - **Antibiotic** acts as a **Selection Agent** . - Individuals with traits best suited for survival (fittest), survive and reproduce more often, increasing **allele frequency** of the **favourable trait** (**antibiotic resistance**).	2
Describes some aspects of the mechanisms of evolution	1

Sample Answer:

This experiment demonstrates the process of natural selection as stated by Darwin's theory of evolution, the bacteria population in petri-dish A first experienced a change of environment: adding the antibiotic. Those that are not suited ~~or~~ to this new environment died and were unable to reproduce. But due to the genetic variance within the original, the "fitter" bacteria which is better adopted to its new environment (having resistance to antibiotics) survives, and reproduced offspring that inherited its genetic information. After this, the colony of bacteria adapted to antibiotics, ~~and~~ ~~can't~~ achieved through natural selection, so when antibiotics were again introduced, the new adapted population were no longer affected.

3

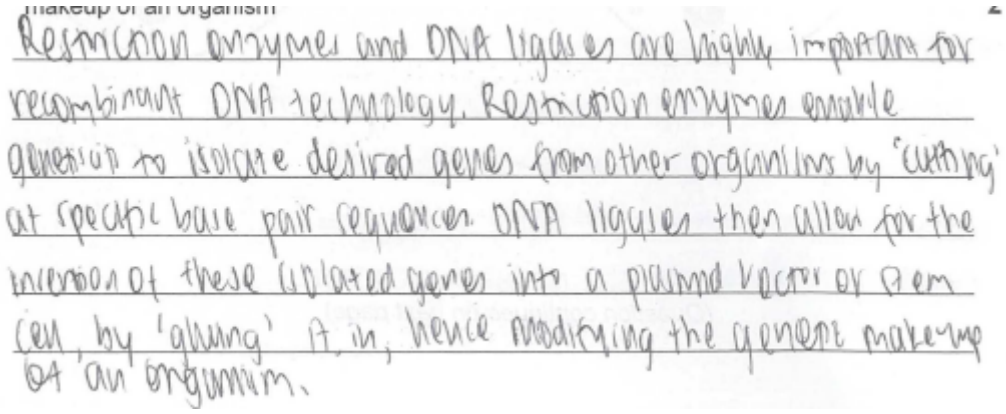
Question 2 (2 marks)

Genetic engineering is a technology that is increasingly being used today in agriculture, industry, and medicine.

Explain the role of *restriction enzymes* in modifying the genetic makeup of an organism **2**

Criteria	Marks
○ Function of *Restriction enzymes and ligases* outlined ○ Explains how they can modify DNA	2
○ Function of *Restriction enzymes and/or ligases* outlined	1

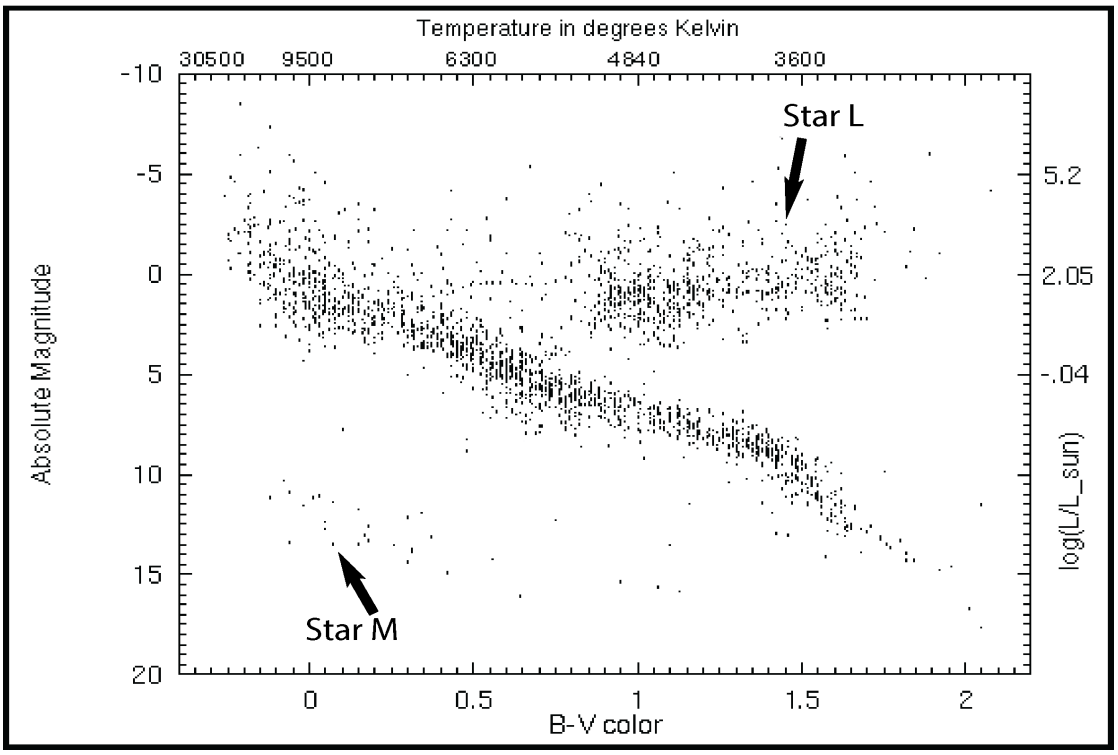
Sample Answer:


makeup of an organism 2

Restriction enzymes and DNA ligases are highly important for recombinant DNA technology. Restriction enzymes enable genetics to isolate desired genes from other organisms by 'cutting' at specific base pair sequences. DNA ligases then allow for the insertion of these isolated genes into a plasmid vector or stem cell, by 'gluing' it in, hence modifying the genetic makeup of an organism.

Question 3 (5 marks)

A *HR Diagram* is used to classify the different types of stars observed in the universe.



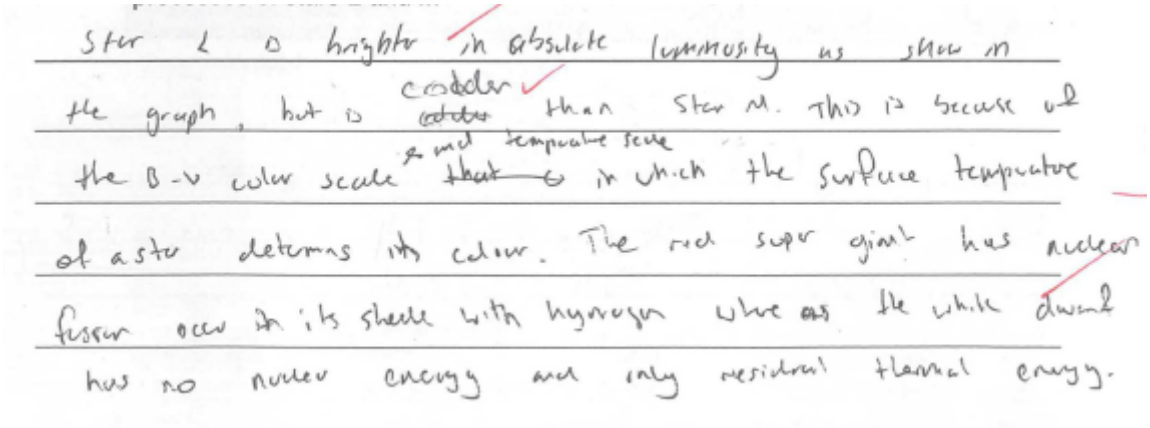
a) By using the HR diagram, identify the type of star L and M. **2**

Criteria	Marks
L is a red giant (or red supergiant) **AND** M is a white dwarf	2
L is a red giant (or red supergiant) **OR** M is a white dwarf	1

b) Qualitatively compare the surface temperature, luminosity, and nuclear processes of stars L and M.

Criteria	Marks
- Nuclear processes: L is towards the end of the star's life, fusing heavier elements, M is at core remnant of a lighter star, no fusion is occurring. - Luminosity: L is much brighter than M. - Surface temperature: The surface of M is cooler than L.	3
2 of the above	2
1 of the above	1

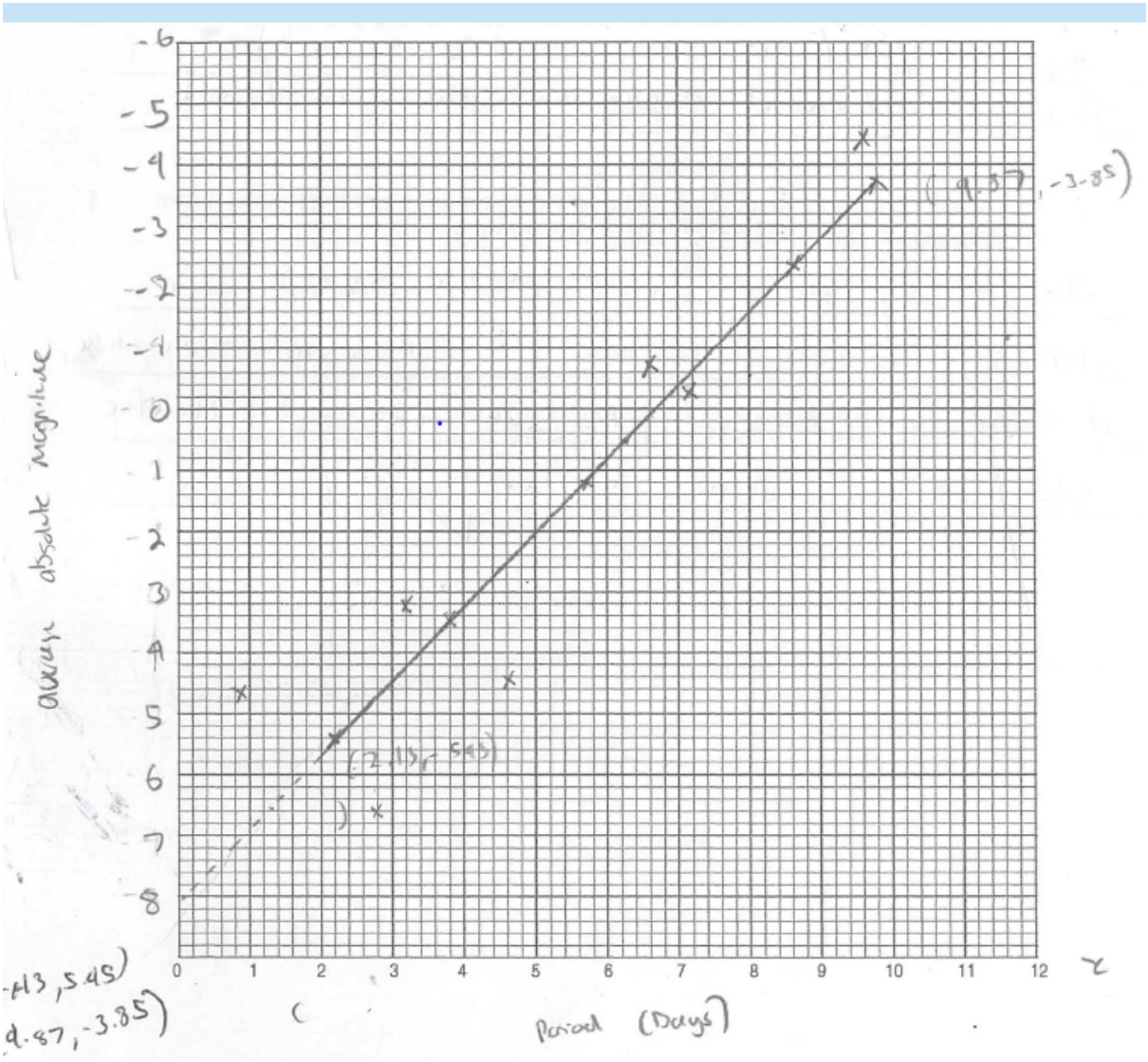
Sample Answer: **3**



Question 4 (10 marks)

Graph the data provided in the table on the grid below **5**

a)



One mark for each of the following:

- Points plotted correctly
- Correct line of best fit
- Axes labelled with units
- Correct linear scale.
- Title

Markers notes:

Graphing skills are very poor.

- Line of best fit should go close to 6 points.
- Period v average absolute magnitude is not a title
- Points should be crosses.
- Use a rule for the line, don't draw freehand
- Line shouldn't go beyond the last data point
- Y-axis scale, best practice is to show understanding of absolute magnitude and numbers should increase up the y axis. Both were accepted as gradient still the same.

b) Showing all working, use your graph to calculate the gradient of the LOBF and the *y-intercept* **2**

- 2 Marks –
  - Use the LOBF to calculate the gradient, showing all working (~-1.27,)
  - Read off the graph the y intercept (~8.2)

Fractions were not accepted as final answers as not accepted in Science answers. Don't do the approximate sign in Science.
Data points for the gradient must be on your line of best fit and stated.
SHOW ALL working out.
Equations not accepted as a final answer. This is not a maths exam.
Y-intercept was determined by extrapolating off your graph. Many off your calculations don't make sense when looking at your graphs.
If you didn't draw a line of best fit in part a, you couldn't answer this question.

c) The periods of two distant stars *X* and *Y* are measured to be 6.25 days and 1.31 days respectively. From your graph, determine the average absolute magnitude of these stars **2**

Criteria	**Mark**
○ Star X = 0.1 ○ AND Star Y = 6.2 Either read off the graph or using the equation of the LOBF	2
○ Star X = 0.1 ○ OR Star Y = 6.2 Either read off the graph or using the equation of the LOBF	1

Identified values MUST have been able to be obtained from the graph. In most instances equation for LOBF did not reflect the drawn line on their graph. A lot of calculations resulted in points that were not on the LOBF. Students should be double checking their results with their graph. No marks were given if no LOBF was drawn.

A lot of students lost marks as their positioning when reading 0.25 and 0.31 off the horizontal axis was the same. Given the intervals were 0.2, 6.25 should have been read close to the 6.2 demarcation and 1.31 should have been read halfway between the 0.2 and 0.4 demarcations.

Students lost a mark if they reported the absolute magnitudes to ridiculous levels of precision. The resolution of the graph was 0.2. Which means AT MOST measurements within an uncertainty of 0.1 could be made. Reporting absolute magnitudes up to 3 or 4 decimal places is unrealistic to be read off the graph.

Students did not read the question and understand the data presented. A lot of students found the mean of the "average absolute magnitude" of stars X and Y. The plotted graph WAS of average absolute magnitude.

d) As viewed from earth, stars X and Y have the same apparent brightness. From the data above, determine which star is closer to the earth **1**

Criteria	Mark
Star Y is closer to Earth.	1

An understanding of absolute vs apparent brightness is needed. Absolute magnitude is a measurement taken as if both stars were the same distance from Earth. Apparent is how they look in the sky. If they have the same apparent brightness but star Y is less bright (larger absolute magnitude) this means that star Y must be closer to Earth.

Students should also start to appreciate the length of a response and the amount of marks. This questions was worth 1 mark (identify) – it did not need a length response (explain/describe/judge).