Penrith High School

Year 12
Trial Examination
2007

Physics

General Instructions

- Reading time – 5 minutes
- Exam time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Answers written in pencil will be disqualified from review
- A Data Sheet, Formulae Sheets and List of Verbs are provided at the back of this paper.

Total marks (100)

There are two Sections

Section I

Part A – Fifteen 1-Mark Multiple Choice Questions

Total marks (15)

- Attempt Questions 1 – 15
- Allow about 25 minutes for this part

Part B - Free Response Questions

Total marks (60)

- Attempt Questions 16 – 31
- Allow about 1 hour and 50 minutes for this part

Section II - Options

Total marks (25)

- Attempt Quanta to Quarks; Question 32A

OR

- Attempt Astrophysics; Question 32B
- Allow about 45 minutes for this part

Messrs Burns and Mills

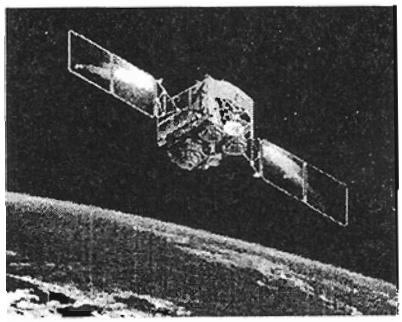
The Exam Paper must be submitted at the end of the examination.

STUDENT'S NAME _____

TEACHER : _____

Section I Part A – Fifteen 1 - Mark Multiple Choice Questions

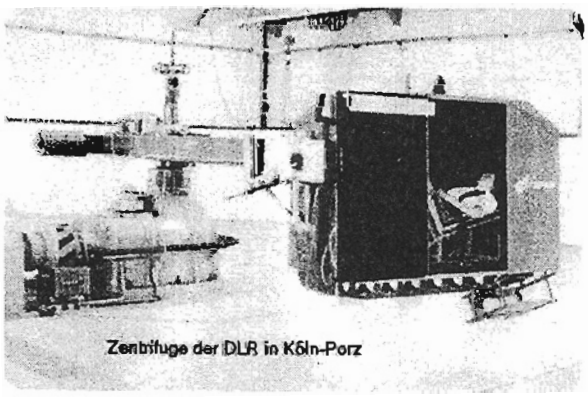
1. A particular satellite takes approximately 1.5 hours to orbit the earth at an altitude of 350 km above the earth's surface.



If the radius of the earth is 6 400 km, then the time it will take for the satellite to orbit the earth at an altitude of 500 km is:

(A) 1.02 hours
(B) 1.55 hours
(C) 2.40 hours
(D) 4.05 hours

2. An astronaut must be trained to cope with high "g forces". This training may involve sitting in a centrifuge (a cabin that spins at very high speed).

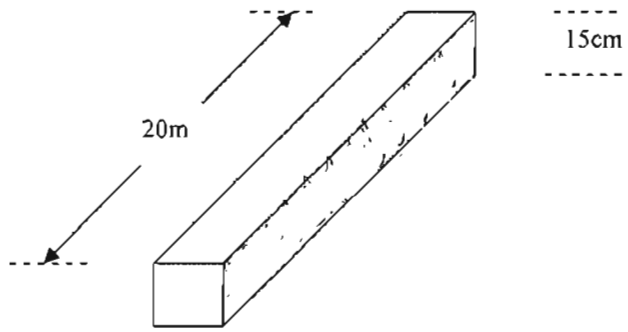


http://www.lrt.mw.tum.de/en/interessierte/fs_wie_wird_man_astronaut.phtml

The length of the radial arm between the pivot and the centre of mass of the cabin is 5.0 m and the cabin is spun in a horizontal circle such it has a linear velocity of 21.0 ms^{-1}. Calculate the "g force" the astronaut experiences while riding the centrifuge.

(A) 4.03 g's
(B) 6.52 g's
(C) 9.00 g's
(D) 88.2 g's

3. Charged particles can travel through an evacuated space inside a hollow rectangular conduit that has a length of 20m and a height of 15cm.

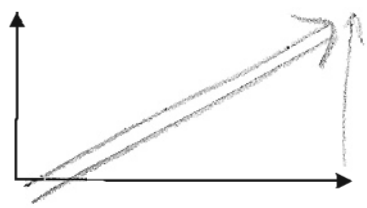


A charged particle that travels through the conduit at 10^8 ms^{-1} would measure the area of the shaded side of the conduit as being:

(A) 283 m^2
(B) 3.0 m^2
(C) 2.83 m^2
(D) 2.66 m^2

4. The horizontal velocity and vertical velocity of a projectile were measured and are represented by the following vectors.

Vertical velocity
= 5.0 m/s



Horizontal velocity
= 10.0 m/s

The actual velocity of the projectile is:

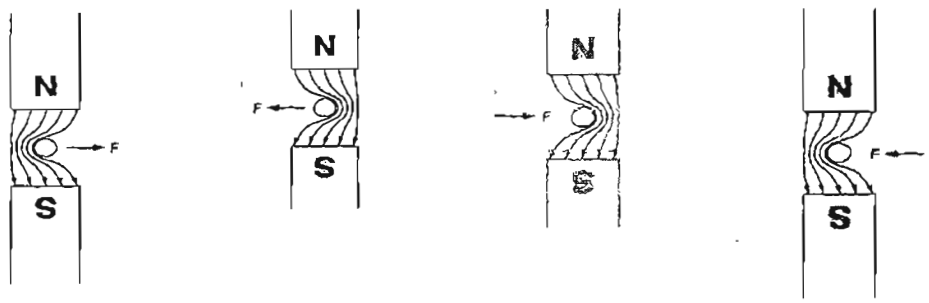
(A) 15 m/s at 45° to the horizontal
(B) 15 m/s at 26.6° to the horizontal
(C) 11.2 m/s at 26.6° to the horizontal
(D) 11.2 m/s at 30° to the horizontal

5. The space-scientist credited with deriving the mathematics to correctly describe the launch of a variable-mass rocket was:

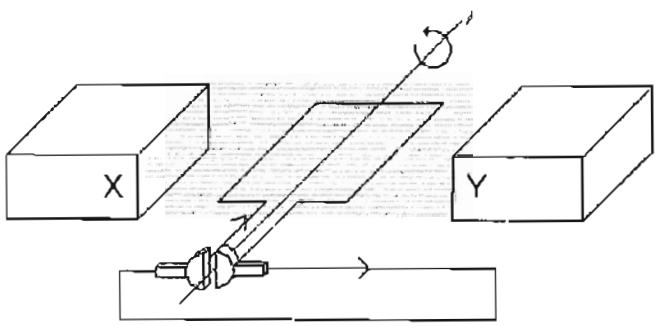
(A) Tsiolkovsky
(B) Oberth
(C) Goddard
(D) Esnault-Pelterie

6. A straight conductor carrying an electric current is situated between and at right angles to a magnetic induction between the poles of two bar magnets. The conventional current is directed <u>out</u> of the page.
The diagram that best represents the interaction between the field of the magnets and that of the wire is:

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



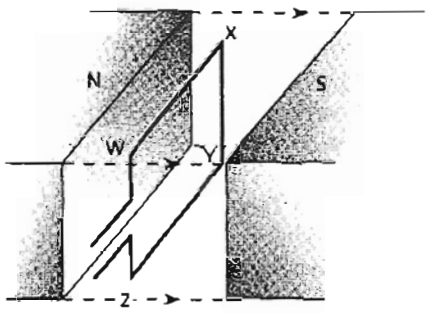
7. The diagram below represents a DC generator.



The poles that must be placed at X and Y in order for the generated conventional current to flow as indicated are:

	X	Y
(A)	N	N
(B)	N	S
(C)	S	N
(D)	S	S

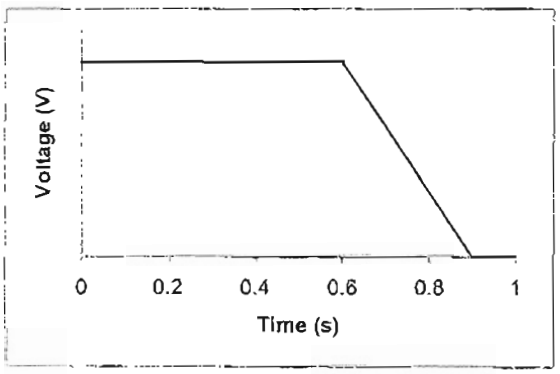
8. A rectangular coil of wire WXYZ is placed in a uniform magnetic induction (B) as shown.



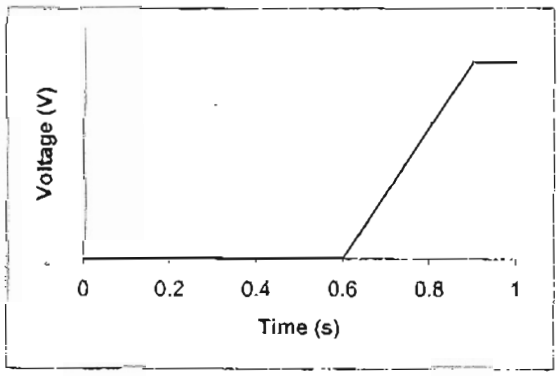
The entire coil is in the magnetic induction for 0.6 seconds. A student then moves the coil vertically upwards with a uniform speed so that the coil leaves the field between 0.6 secs and 0.9 secs.

Which one of the following graphs best shows the variation of the voltage across the ends of the coil with time.

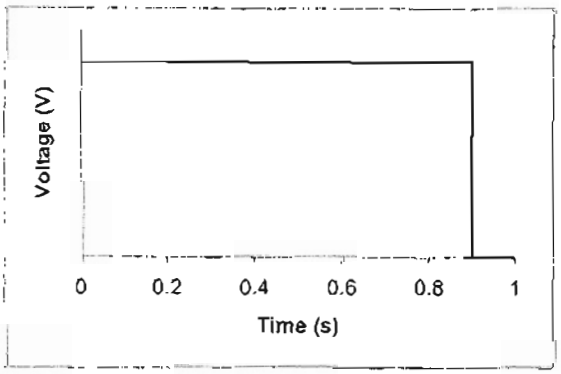
(A)



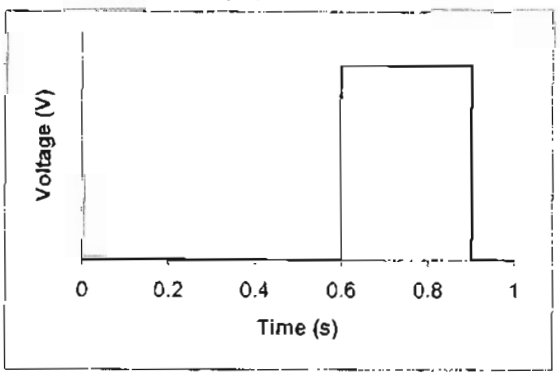
(B)



(C)



(D)

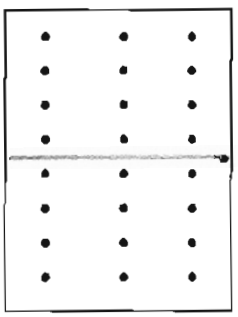


9. A transformer has a primary coil with 60 turns and a secondary coil with 2300 turns. If the primary voltage to the transformer is 110 Volts then the secondary voltage is:

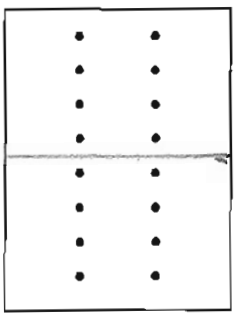
(A) 2.4×10^{-2} Volts
(B) 2.9 Volts
(C) 4.2 Volts
(D) 4.2×10^{3} Volts

10. Which rectangle contains the greatest magnetic flux density?

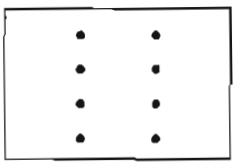
(I)



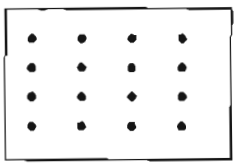
(II)



(III)

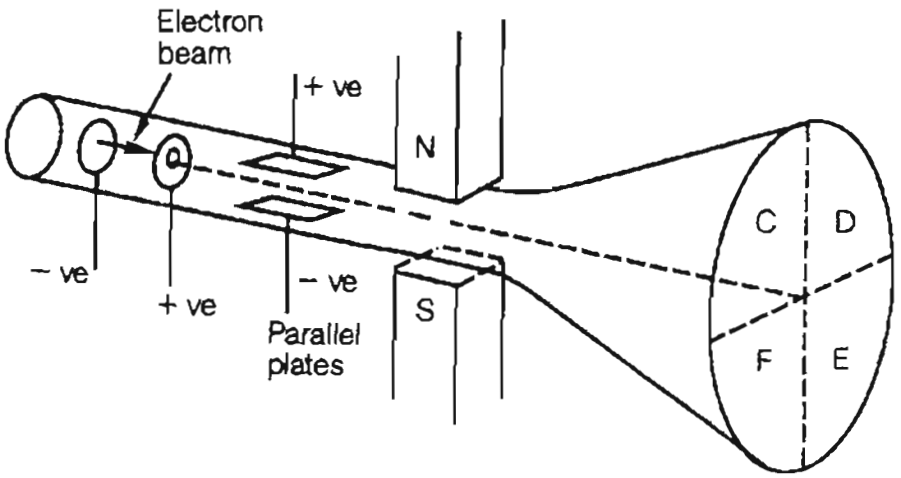


(IV)



	Magnetic Flux Density
(A)	I
(B)	II
(C)	III
(D)	IV

11. The diagram shows an evacuated cathode ray tube in which an electron beam travels towards a screen divided into four regions C, D, E and F.



The region to which the electron beam will be deflected should both the electric and magnetic fields be operating is:

(A) C
(B) D
(C) E
(D) F

12. Heinrich Hertz tried a variation in his experiment but failed to recognise its significance to the photoelectric effect.

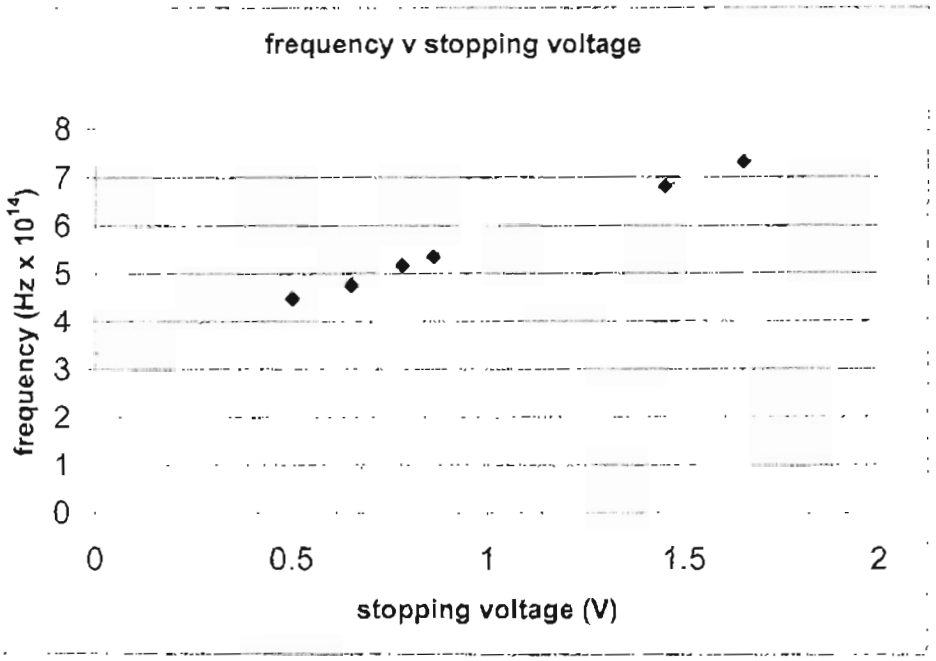
Hertz noticed that sparks:

(A) were of an increased intensity when he illuminated the gap between the electrodes with radiation of long wavelengths
(B) were of an increased intensity when he repeated the experiment in a closed nitrogen vessel
(C) more readily occurred in the gap between electrodes if the electrodes were exposed to infrared light
(D) more readily occurred in the gap between electrodes if the electrodes were exposed to ultraviolet light

13. The cathode of a photoelectric cell is illuminated successively by light of different frequencies. The equation that describes the experiment is;

$$qV = hf - \Phi$$

A plot of the frequencies of light against the stopping potentials is shown below.



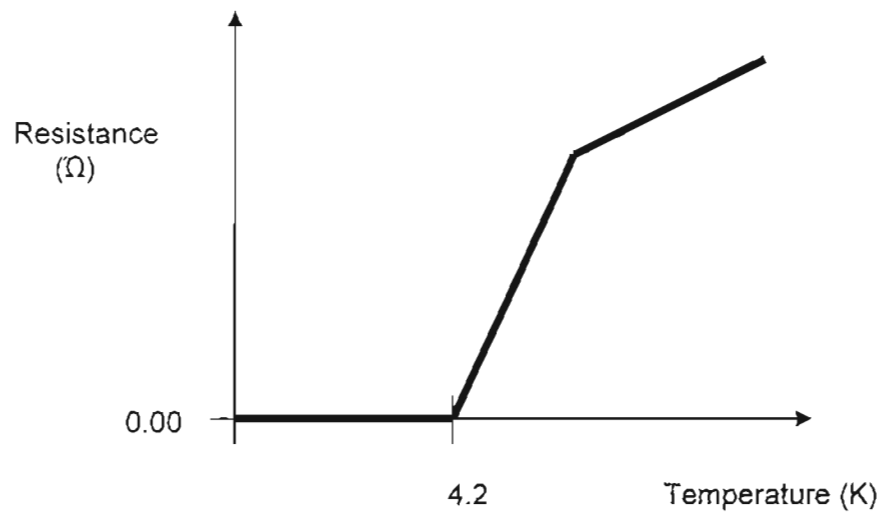
From the graph, the threshold frequency and the work function of the metal can be calculated as:

(A) 3.2 Hz and 2.1×10^{-19} J
(B) 3.2×10^{14} Hz and 2.1×10^{-19} J
(C) 3.2 Hz and 2.1 J
(D) 3.2×10^{14} Hz and 2.1 J

14. Which of the following lists the four substances in order of increasing numbers of conduction electrons?

(A) Pure silicon, n-type silicon, glass, copper
(B) Copper, n-type silicon, pure silicon, glass
(C) Glass, pure silicon, n-type silicon, copper
(D) Glass, n-type silicon, pure silicon, copper

15. The variation of the resistance of the metal Mercury with temperature is shown in the graph.



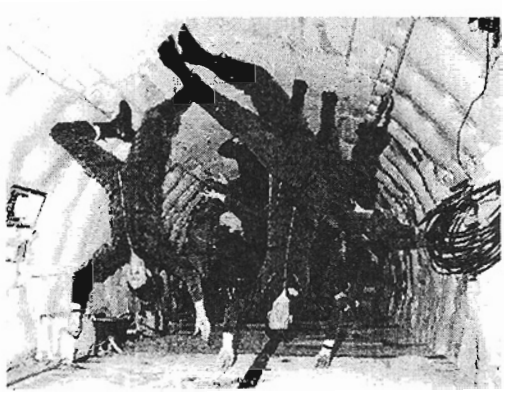
This graph indicates that mercury can behave as a:

(A) Semiconductor below 4.2 K
(B) Superconductor above 4.2 K
(C) Semiconductor above 4.2 K
(D) Superconductor below 4.2 K

Section I Part B – Free Response Questions

Answer Questions 16-31 (Total Marks 60)

16. In the film "Apollo 13", the astronauts are shown to be 'weightless'.



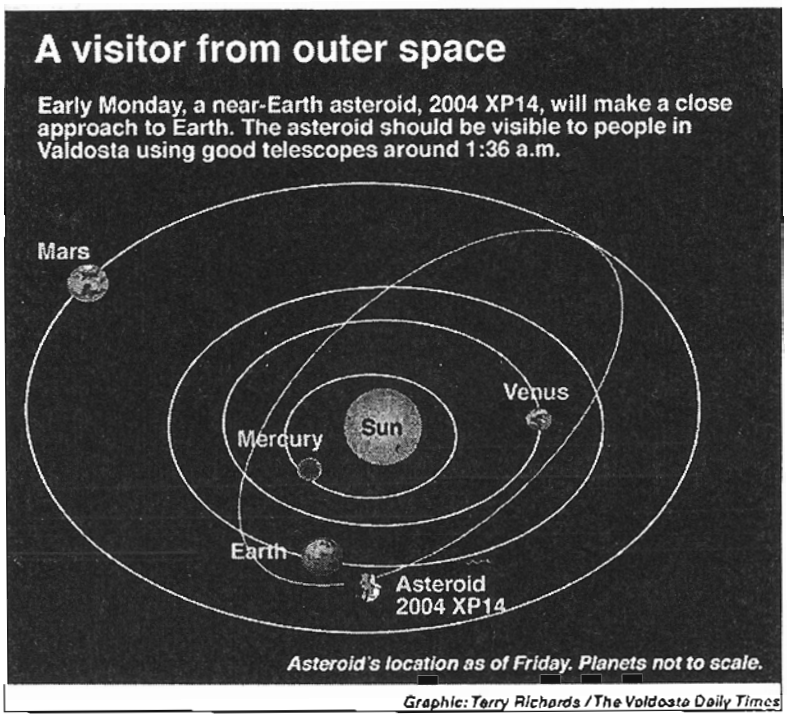
A physics student expressed the opinion that true weightlessness can only be experienced in the absence of a gravitational field. 3m
State whether or not you agree with the student and use the principles of physics to justify your viewpoint.

17. Describe the effect of the Earth's orbital motion and its rotational motion on the launch of a rocket. 4m

18. Outline the issues associated with;

(i) safe re-entry into the Earth's atmosphere, and
(ii) that there is an optimum angle for safe re-entry for a manned spacecraft into the Earth's atmosphere and the consequences of failing to achieve this angle 2m

19. The following image accompanied an article in an overseas newspaper about the approach towards Earth of an asteroid named 2004 XP14. The asteroid was approximately 0.8 km in diameter and was travelling at 17 kilometres per second. It was expected to pass within a moon orbit of earth.



You have been invited to attend a student seminar by the local university to give a lecture on the physics relevant to this event.
Analyse the image carefully and identify the principles of physics you learned about in the Space topic so that you might use them for an accurate explanation of the asteroid's motion.

Use bullets (dot points) to list the principles you identified and briefly explain how each of your listed principles applies to the asteroid's motion. 8m

Additional writing space is available on the next page.

20. Using no more than two or three sentences for each, summarise the following;

(i) the aether model for the transmission of light; 2m

(ii) the nature of inertial frames of reference 2m

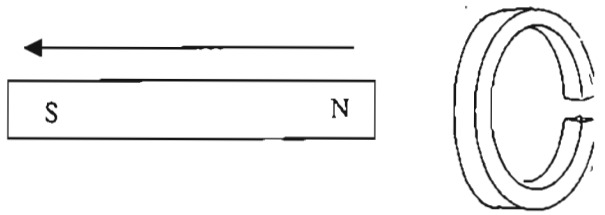
(iii) the significance of Einstein's assumption of the constancy of the speed of light 2m

(iv) one of Einstein's thought experiments involving mirrors and trains and its significance. 2m

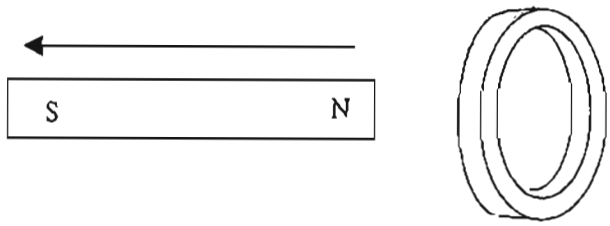
21. (i) Clarify the essential meaning of both Faraday's and Lenz's Laws. 2m

The following diagram shows a bar magnet being removed from two types of conducting rings.

(A)



(B)



(ii) Label each ring with the direction (if present) of an EMF and induced current. 3m

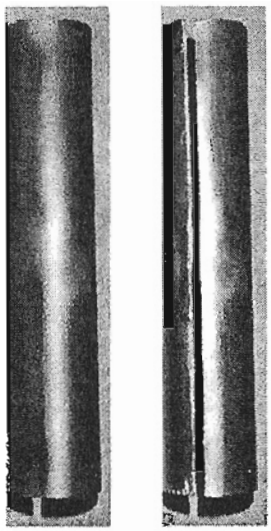
(iii) Briefly outline the reasons for each decision you make. 3m

22. When using a drill the motor can sometimes overheat.

Explain why the motor of the drill should not overheat when operated at full speed but may overheat if the rotation of the motor slows. 2m

23. Two students conducted an experiment by dropping a neodymium magnet down a one-metre length of copper pipe.

Pipe A **Pipe B**



When using Pipe A the students noted that the magnet descended much more slowly than if an unmagnetised object was dropped down the pipe.

(i) Use labelled diagrams to explain this observation. 2m

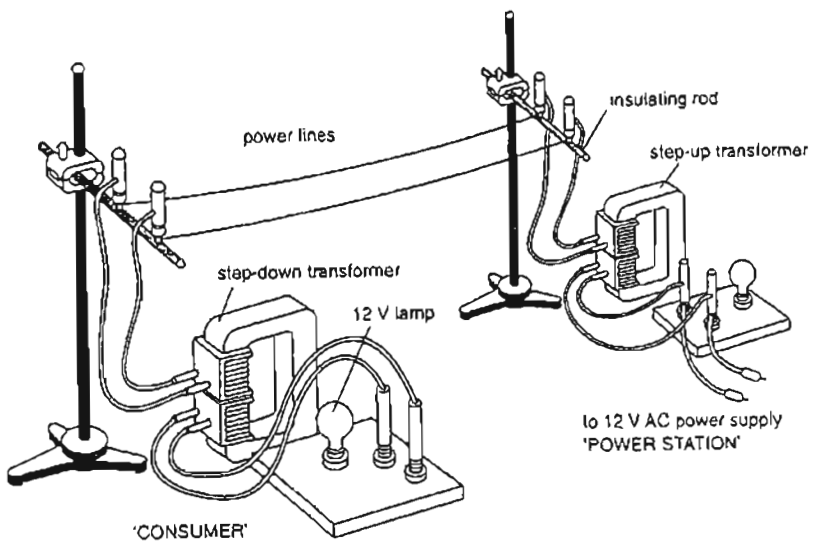
The students repeated the experiment, but this time used the one-metre copper pipe with the slit cut along its length (Pipe B).
One student believed that the magnet would fall as quickly as the unmagnetised object.
The other student believed that the magnet would still fall slowly with little difference to the original experiment.

(ii) Which student is likely to be correct, if either, and outline your reasoning. 2m

Each student agreed that in the second experiment the magnet tilted to one side during its descent down the pipe (Pipe B).

(iii) In which direction would the magnet have tilted, and justify your answer. 2m

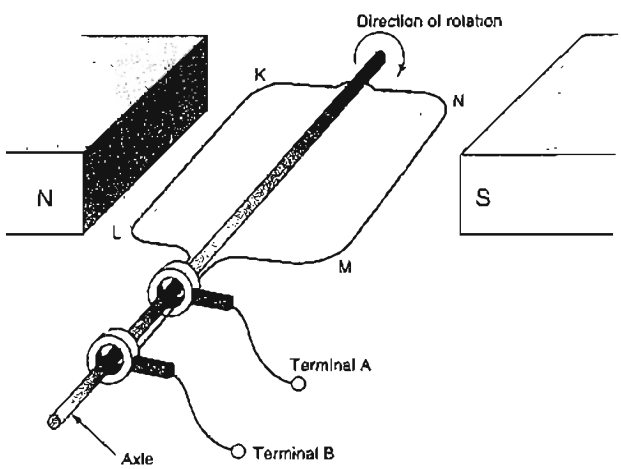
24. The model illustrated demonstrates important principles about the transmission of electrical energy over long distances.



Analyse the model carefully and describe all the important principles of transmission that you can identify. 5m

Additional writing space is available on the next page.

25. An AC generator is primed such that it rotates clockwise as shown in the diagram.

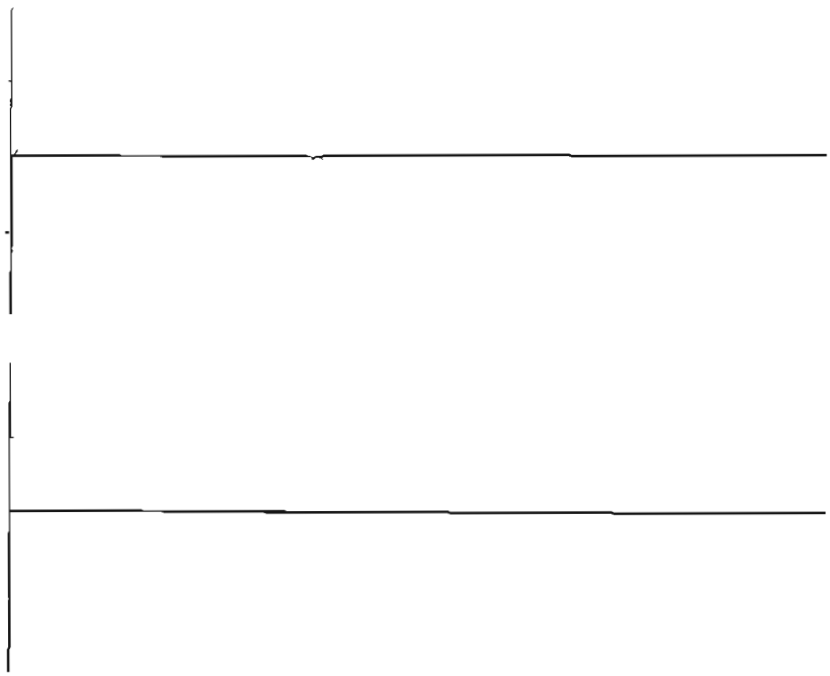


At the instant shown;

(i) Analyse the motion to determine the direction of the induced emf. 1m

(ii) Identify the positive terminal and how you would use a voltmeter to measure the emf induced across the loop. 1m

(iii) Plot a graph of flux against the angle of rotation (θ) and a graph of emf against the angle or rotation (θ) for one rotation of the loop, starting at the position shown in the diagram. 2m

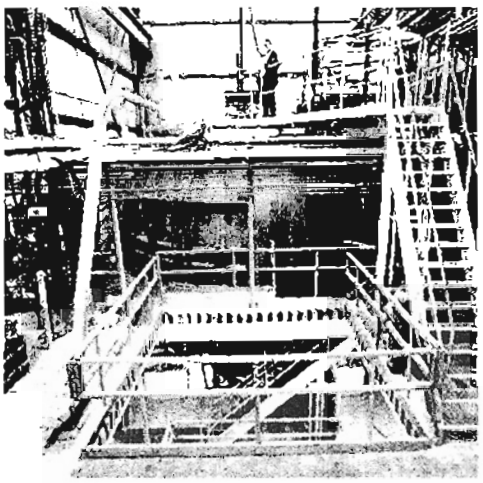


26. During class an investigation was performed to observe the occurrence of different striation patterns for different pressures in discharge tubes.
Clarify the important principles that enabled a satisfactory explanation of the cause and longevity of the striation patterns. 3m

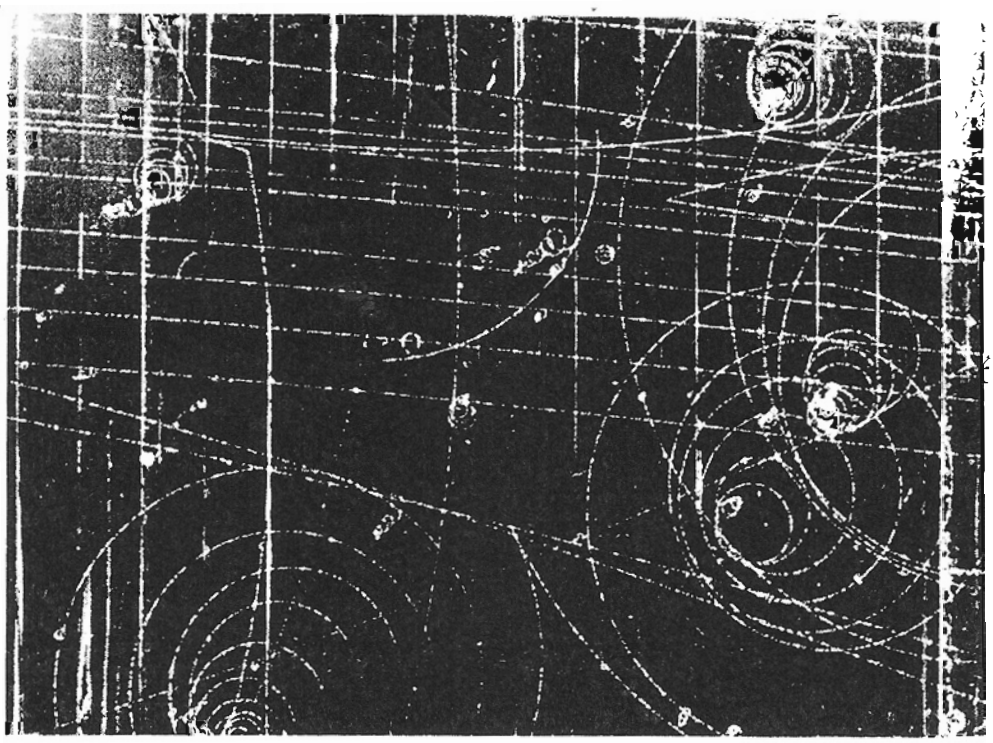
27. A bubble chamber was an early method to study sub-atomic particles.

The chamber often contained liquid hydrogen. Particles entering the chamber would transfer some of their energy to the hydrogen, resulting in boiling and the formation of bubbles. Therefore, particles passing through the chamber under the influence of an external magnetic field would leave observable tracks that could be photographed and analysed.

A typical bubble chamber is shown.



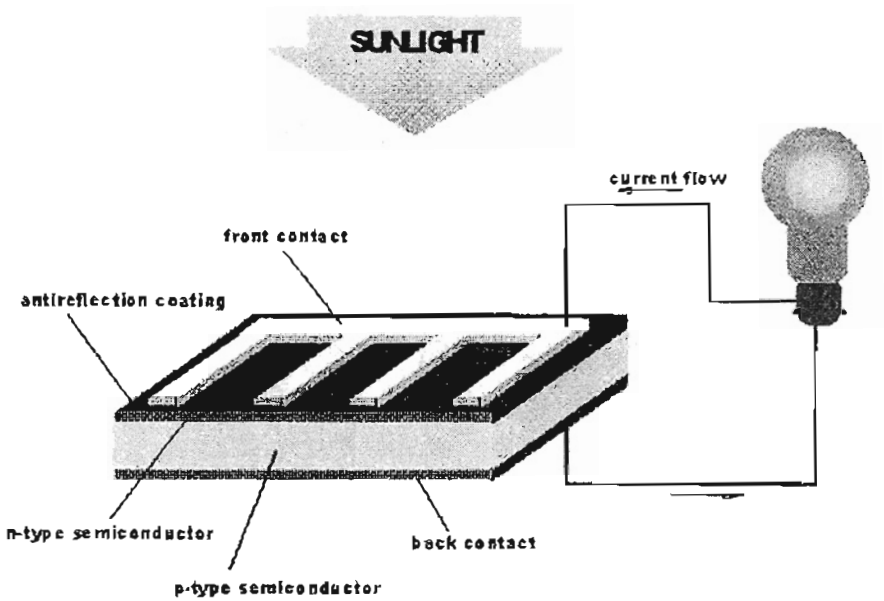
The following diagram is a photograph of the particle tracks that formed during a bubble chamber experiment.



Use your knowledge of physics to obtain whatever information you can from the photograph. Justify your interpretations. Ensure in each case you clearly identify the part of the photograph you are analysing. 4m

28. Summarise Einstein's contribution to quantum theory and its relation to black body radiation. 3m

29. The principles of a solar cell are outlined in the diagram below.



http://www.shodor.org/ssep/prl/duketech/techtronics/lessons/solar_energy/assets_solar/solar_energy_images/78.jpg

Use the diagram and your knowledge of physics to fully explain all the processes that result in an electric current. 4m

30. Outline differences between solid state and thermionic devices. 3m

31. Use band theory to explain and compare conduction and resistance in metals, semi-conductors and Type I superconductors (eg Mercury). 8m

Question 32B : Astrophysics

(i) Name two wavebands that cannot be successfully used for ground-based observations and identify the sources of radiation absorption that prevents their use. 4m

(ii) (a) Define the terms 'resolution' and 'sensitivity' when applied to telescopes. 2m

(ii) (b) Nominate two typical night-time observations that could be made using hand-held telescopes and discuss how a knowledge of 'resolution' and 'sensitivity' is important to ensuring the most successful observations. 4m

Additional writing space is available on the next page.

(iii) Describe the principles by which both adaptive optics and active optics improve resolution or sensitivity for ground-based astronomy. 6m

(iv) Evaluate the usefulness of trigonometric parallax as a method of measuring the distance of stars. 4m

(v) An astronomer recorded between March and September 2006 a shift in a faint, though highly significant star, Gamma Penrithica, which was low in the western sky in the field of Zaurak.

The astronomer produced two highly magnified images (to be found on following pages) that are identified by their dates.
The astronomer circled the March image with the stars that had experienced relative movement.

(a) Compare the two images closely and identify which of the two stars is Gamma Penrithica. 1m

The astronomer drew a horizontal line AB on the March image between the two vertical lines of right ascension.

(b) Measure the length of the line AB in millimetres and record it.

(c) Measure the magnitude of the movement of Gamma Penrithica relative to its adjacent star and record it in millimetres.

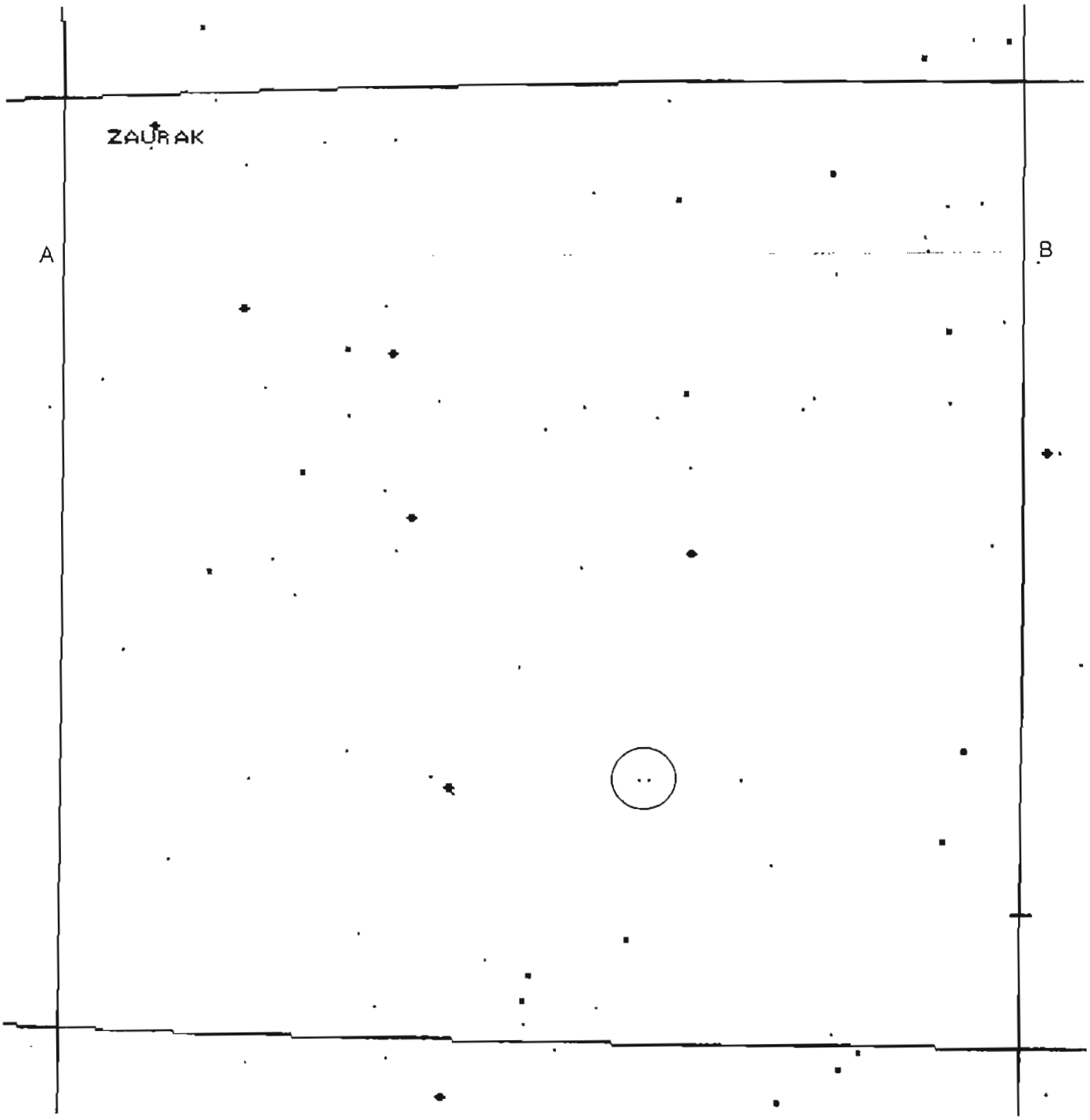
The interval AB between the lines of right ascension on the March image defines an angular separation of 0.0015^0.

(d) Use this scale and your previous measurements to calculate the annual parallax for Gamma Penrithica in arcsecs. 3m

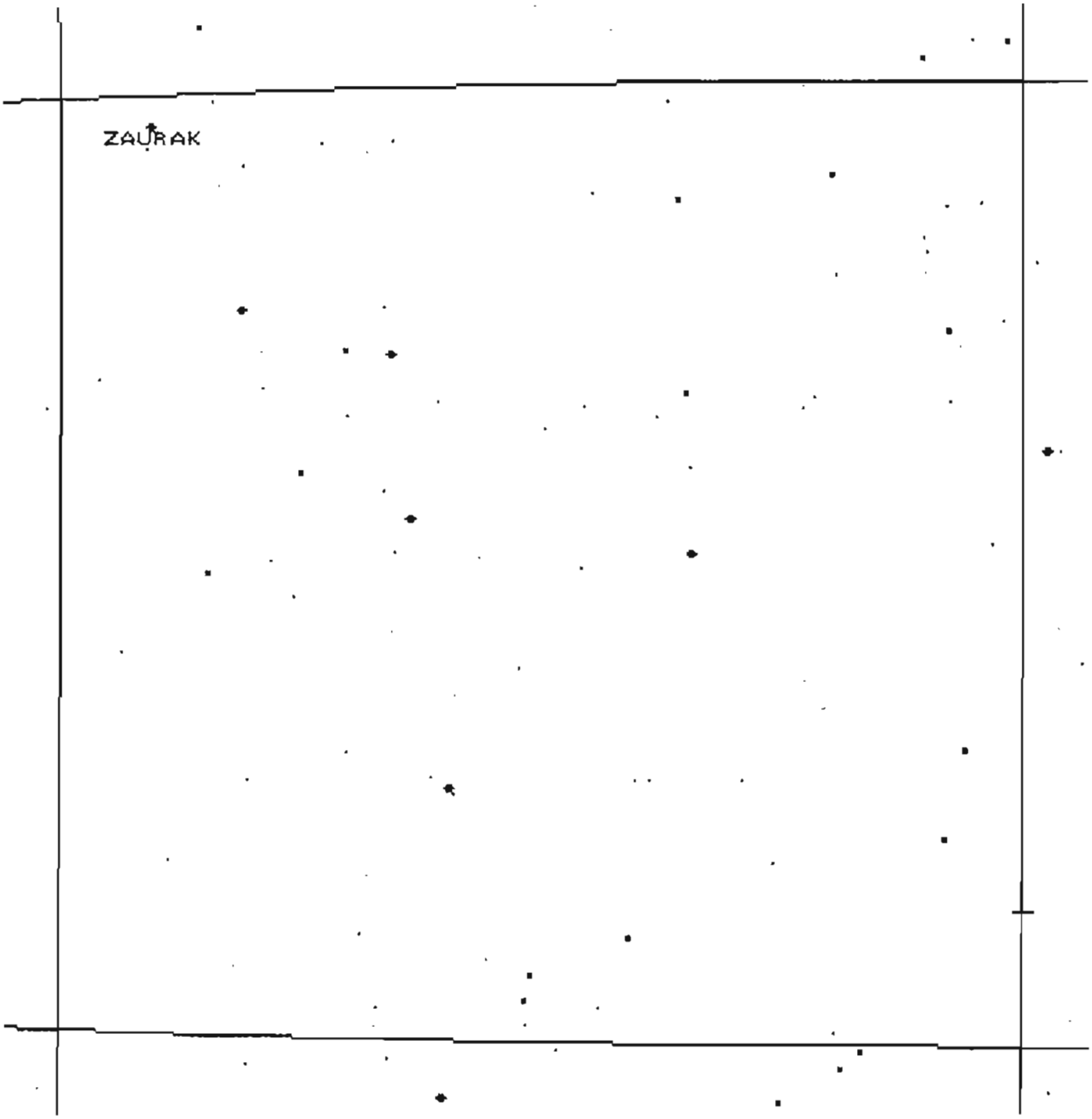
(e) Calculate the distance of Gamma Penrithica from earth. 1m

End of Astrophysics

March 22, 2006



September 22, 2006



Total marks (15)
Attempt Questions 1 – 15
Allow about 25 minutes for this part

MULTIPLE CHOICE ANSWERS

Answer Sheet

Part A

1.	(A) ○	(B) ●	(C) ○	(D) ○
2.	(A) ○	(B) ○	(C) ●	(D) ○
3.	(A) ○	(B) ○	(C) ●	(D) ○
4.	(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) ●
13.	(A) ○	(B) ●	(C) ○	(D) ○
14.	(A) ○	(B) ○	(C) ●	(D) ○
15.	(A) ○	(B) ○	(C) ○	(D) ●

Students may detach this sheet. However, it is the student's responsibility to re-staple it to the examination paper and to write a name on it.

Marks will not be awarded should the sheet be lost.