Penrith High School

Year 12
Trial Examination
2011

Physics

General Instructions

- Reading time – 5 minutes
- Exam time – 3 hrs
- Draw diagrams in pencil
- Board-approved calculators may be used
- Write using blue or black pen
- Answers written in pencil will be disqualified from review
- A Data and Formulae Sheet is provided at the end of this paper.

Total marks (100)

Section I

There are Two Parts

Part A – Twenty 1-Mark Multiple Choice Questions

Total marks (20)

- Attempt Questions 1 – 20
- Allow about 35 minutes for this part

Part B - Free Response Questions

Total marks (45)

- Attempt Questions 21 – 29
- Allow about 1 hour and 20 minutes for this part

Section II

Total Marks (35)

- Allow about 65 minutes for this part

The Exam Paper and all other materials used must be submitted at the end of the examination.

STUDENT"S NAME: _____

Section I: Part A – Instructions for Multiple Choice Questions

Use the multiple-choice answer sheet provided.

Select the alternative A, B, C or D that best answers the question.
Fill in the response oval completely.

Example 2 + 4 = ?

(A) 2 (B) 6 (C) 8 (D) 9

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

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

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

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word 'correct' and drawing an arrow as follows:

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

Students may detach the answer sheet. However, it is the student‟s responsibility to re-staple it to the examination paper with a name on it.

Marks cannot be awarded if the sheet is lost.

Total marks (20)
Attempt Questions 1 – 20
Allow about 35 minutes for this Part

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) ⬭
16.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
17.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
18.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
19.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
20.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭

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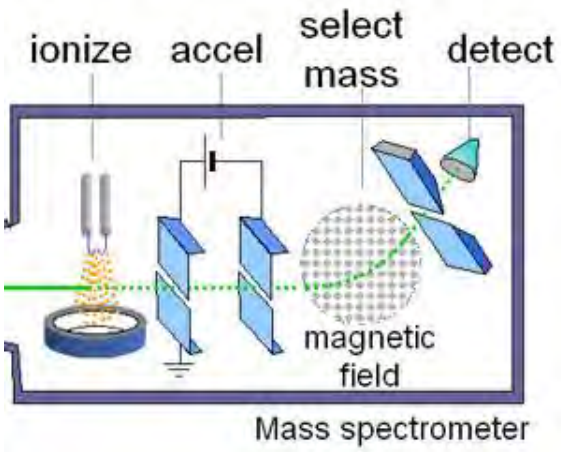
Section I Part A: Twenty 1 – Mark Multiple Choice Questions

1. A mass spectrometer is widely used in chemical analysis to separate ions of different mass (m) and charge (q).
   A type of mass spectrometer is shown in the diagram below.



Mass spectrometer

Atoms ionised by a hot filament are accelerated in an electric field to a velocity of v ms^{-1} before they enter a uniform magnetic field (B). In the magnetic field the atoms experience a centripetal force that results in a circular path of radius r metres.

Oxygen ions of mass 2.7 $x10^{-26}$ kg and a positive charge twice that of the charge of an electron enter the magnetic field B=1.95 T with a velocity of $6x10^{6}$ ms^{-1}.

The radius of the path of the oxygen ions will be closest to;

(A) 0.26 m
(B) 0.52 m
(C) 1.2 m
(D) 4.00 m

2. The cathode ray tubes used in Cathode Ray Oscilloscopes and Televisions use a stream of electrons to produce an image.

Which of the following comparisons of the two devices is incorrect?

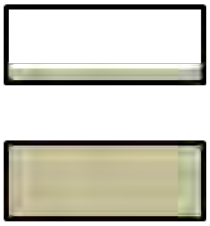
	TV	*CRO*
(A)	Curved tube face	Flat tube face
(B)	Deflection by Electric field	Deflection by Magnetic field
(C)	High electron gun current	Low electron gun current
(D)	Rapid variation in Intensity	Constant Intensity

3. Which of the following band diagrams relate to a material with the highest resistance?

(A)

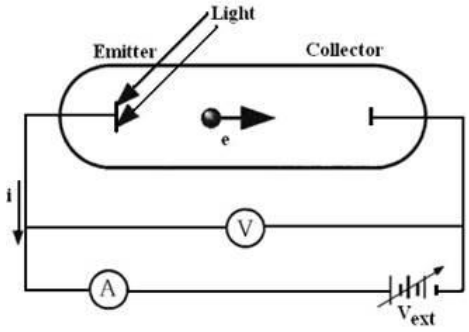
(B)

(C)



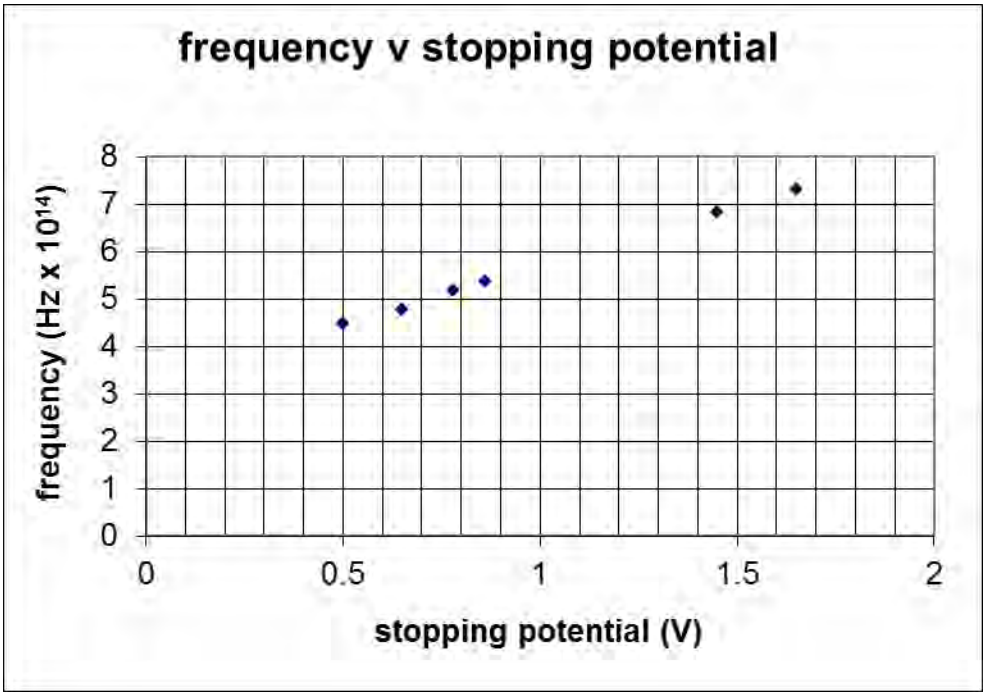
(D)

4. This question refers to the following diagram.



In an experiment to investigate the photoelectric effect, a fresh metal surface is exposed to electromagnetic radiation of a known frequency. A potential difference called the stopping potential (V_{stop}) is applied so that the photocurrent drops to zero.

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



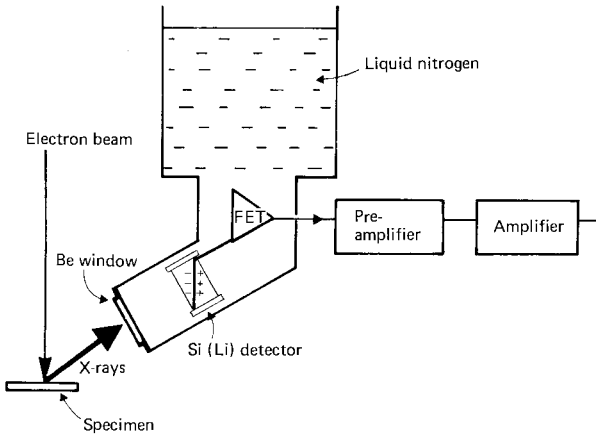
The energy of a photon incident on the metal that would produce an electron requiring a stopping potential of 1.0 volt would be closest to:

(A) 5.6×10^{14} Hz
(B) 3.7×10^{-19} J
(C) 1.6×10^{-19} J
(D) 1.7×10^{23} J

5. This scientific instrument focuses an electron beam onto a sample resulting in an emission of X-rays.

http://www.ucc.ie/en/emf/instruments/

A doped silicon crystal is used to detect the X-rays.



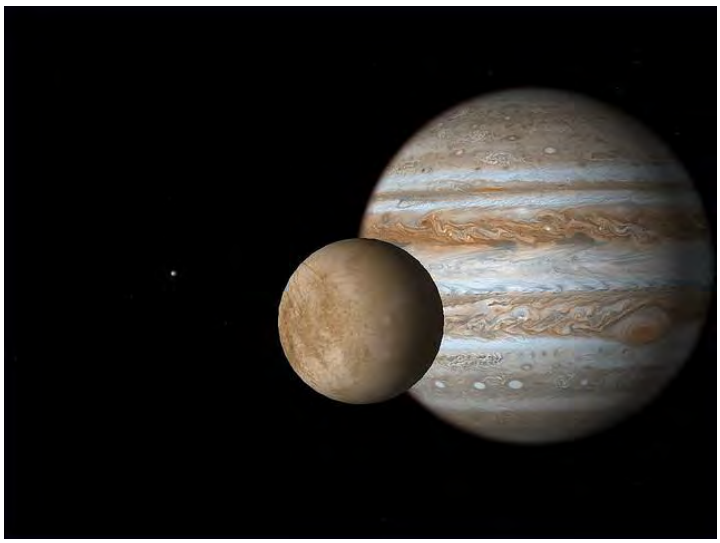
The X-ray photons interact with the crystal resulting in the creation of electron-hole pairs. A photocurrent is produced and its magnitude is directly proportional to the energy of the photons detected.

The solid state detector is cooled by liquid nitrogen to approximately -196^{0}C.

The cooling is necessary because;

(A) The crystal will overheat without cooling
(B) Cooling allows superconducting pairs to pass easily through the crystal with zero resistance
(C) Electrons could be thermally excited into the conduction band and be falsely identified as X-ray counts
(D) The holes become repulsive to photons at high temperatures

6. The following image shows two moons orbiting in Jupiter's gravitational field.

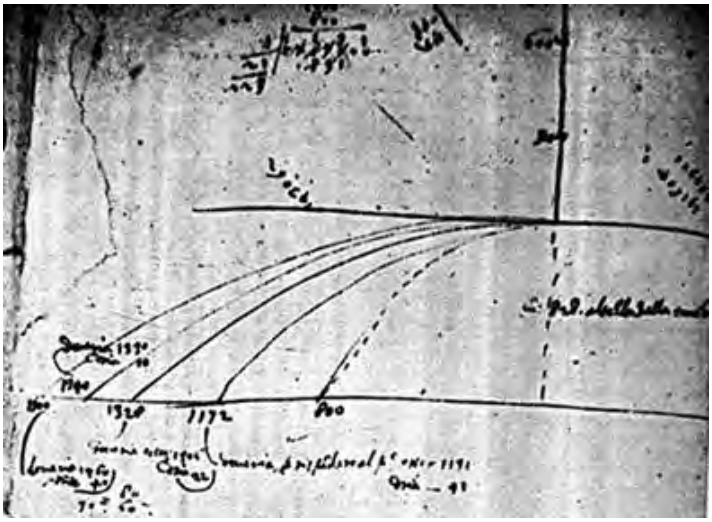


http://www.flickr.com/photos/flyingsinger/120763796/sizes/z/in/photostream/

It is correct to conclude that;

(A) The gravitational field of Jupiter will be stronger at the location of the larger moon because it has greater mass that the smaller moon
(B) Each moon experiences gravitational field strength due to Jupiter expressed by $g = \frac{F}{m}$ where m is the mass of Jupiter
(C) The force each moon experiences with Jupiter is equal in magnitude to the force experienced by Jupiter due to that moon
(D) The force experienced by the smaller moon due to Jupiter is the same as that experienced by the larger moon

7. The following is an image from Galileo"s notebook.

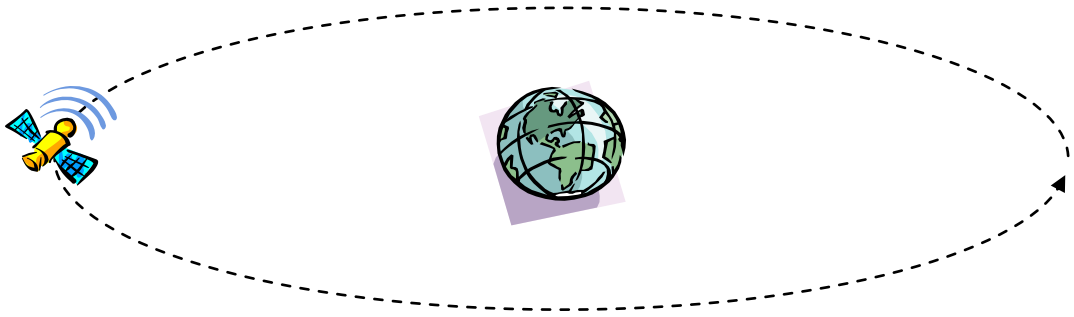


http://galileo.rice.edu/lib/student_work/experiment95/paraintr.html

An important inference that was drawn at the time from Galileo"s understanding of projectile motion and his experiments was that;

(A) The motion of a projectile was made up of two perpendicular components
(B) The two perpendicular motions occurred simultaneously
(C) The two perpendicular motions combined to describe a parabolic path
(D) The earth itself must have had motion through space

8. A satellite is captured in a circular orbit of radius R around the earth as shown.



The work done by the gravitational force around the orbit is:

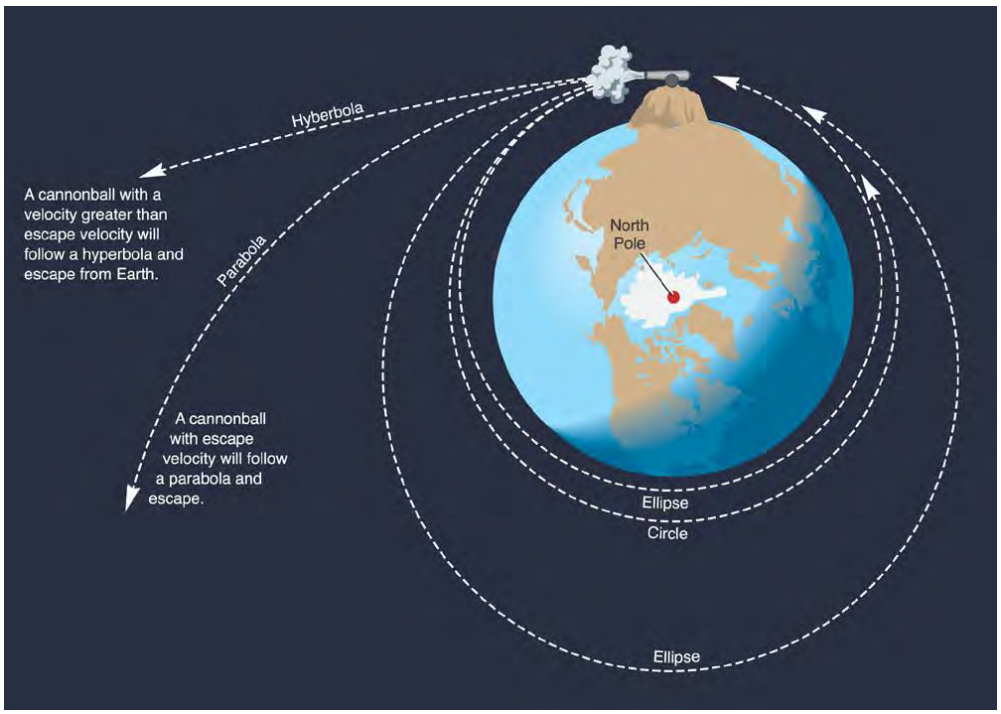
(A) $W = F.s$ where $W>0$

(B) $W = G\dfrac{M_{earth} * M_{sat}}{R^2} \text{x} 2\pi R$

(C) $W = -G\dfrac{M_{earth} * M_{sat}}{R}$

(D) *zero*

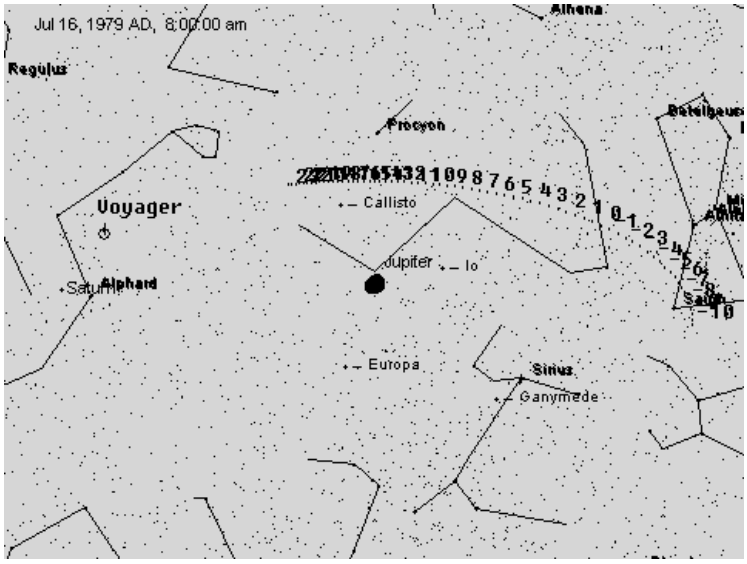
9. The following image illustrates Newton‟s concept of escape velocity.



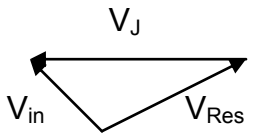
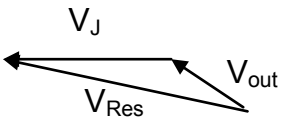
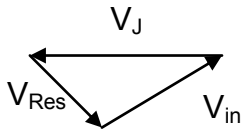
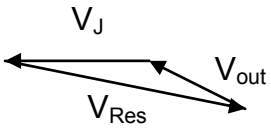
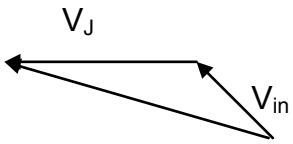
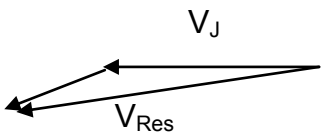
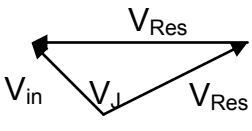
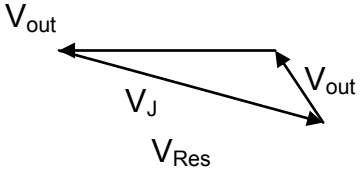
Given the information on the image;

(A) Galileo‟s analysis of projectile motion must have been incorrect because all parabolic projectiles escape the earth‟s gravitational field
(B) The kinetic energy of a projectile must be negative to escape the earth‟s gravitational field
(C) The moon may be considered a projectile that is falling towards the earth with an orbital velocity less than the escape velocity
(D) All hyperbolic projectiles will escape the solar system

10. The image is a computer-generated fly-by of Voyager 2 past Jupiter. The fly-by was from right to left across the image. Voyager is shown moving away from Jupiter having passed by Callisto.

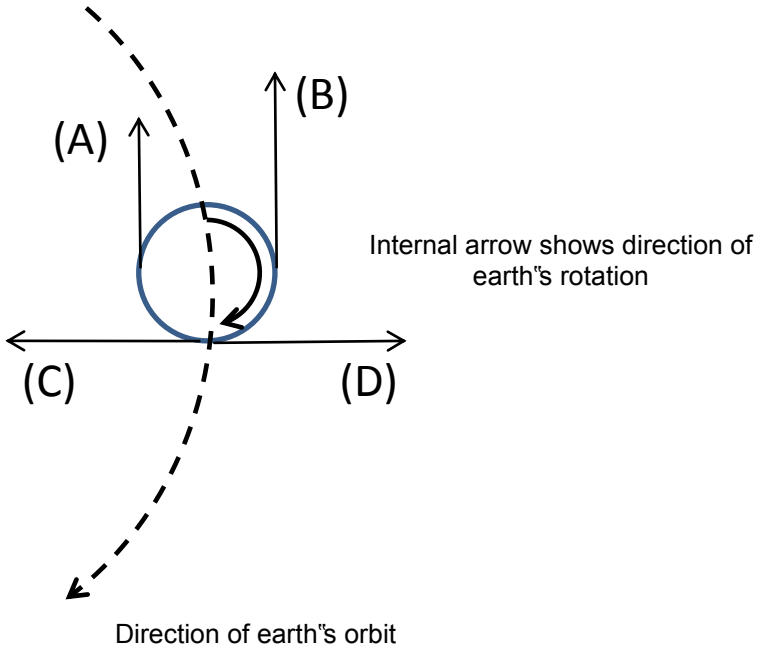


The velocity of Voyager as it approached the fly-by was V_{in} and its velocity on departure from the fly-by was V_{out}. Its resultant velocity was V_{Res} in the solar frame, obtained by adding its V_{in} to Jupiter's velocity V_J on approach, and by adding its V_{out} to Jupiter's velocity V_J on departure.
The pair of vector diagrams (not to scale) that best explain what happened to the velocity of Voyager as it flew by Jupiter are:

	Approach	Departure
(A)		
(B)		
(C)		
(D)		

11. A space probe is launched from Earth in order to orbit Venus.

Which launch direction would require the least fuel?

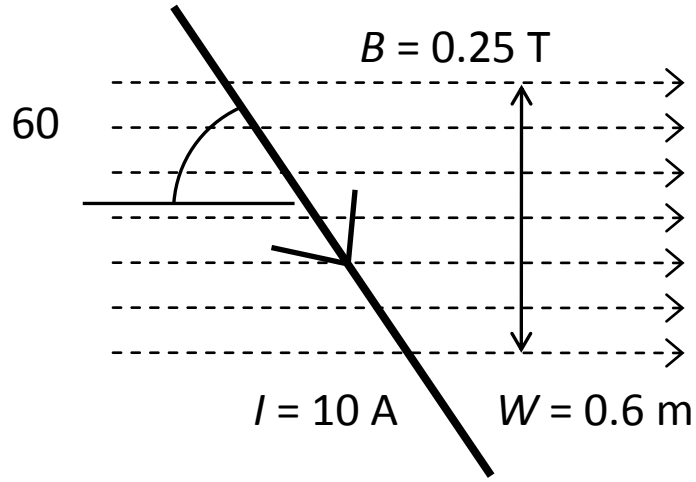


12. Astronauts in the space shuttle orbiting 300km above the earth"s surface experience weightlessness.

This means that at this altitude the astronauts;

(A) Are outside the earth"s gravitational field
(B) Are being accelerated towards the centre of the earth at 8.94ms^{-2}
(C) Must be travelling with an orbital velocity greater than the earth"s escape velocity
(D) Do not possess weight

13. A current of 10 A flows in a wire that is placed at 60° to a magnetic field of B = 0.25 T. The width of the field is 0.6 m.

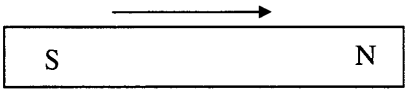


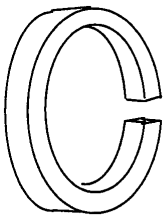
What is the magnitude of the force experienced by the wire?

(A) 0.9 N
(B) 1.5 N
(C) 2.0 N
(D) 3.0 N

14. The following diagram shows a bar magnet being brought closer to two types of conducting rings.

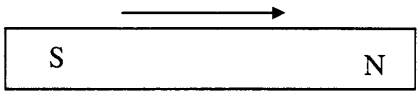
(i)

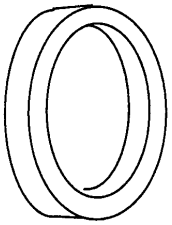




a bar magnet moved through a conductive ring, from outside the ring, until it is halfway

(ii)





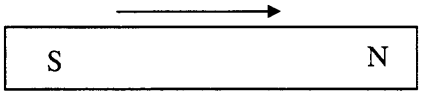
It is most correct to sa

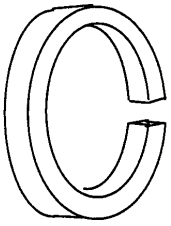
(A) Both an emf and
(B) The emf and cur
(C) The emf induced
bottom of the gap
(D) The emf induced
when the motion

a) Is there an emf in the ring? If so, in what direction?

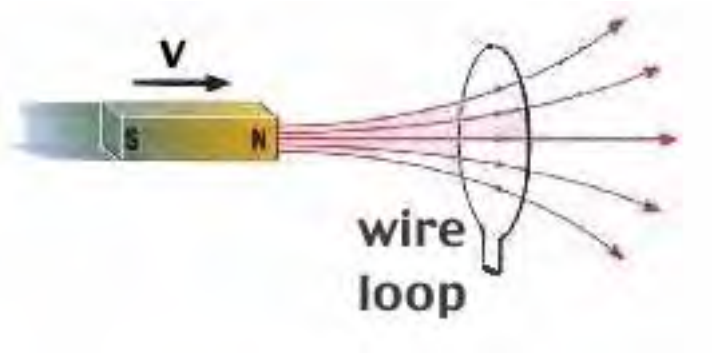
Is there a current in the ring? If so, in what direction?

b) The experiment is repeated, but the ring now has a gap in it.





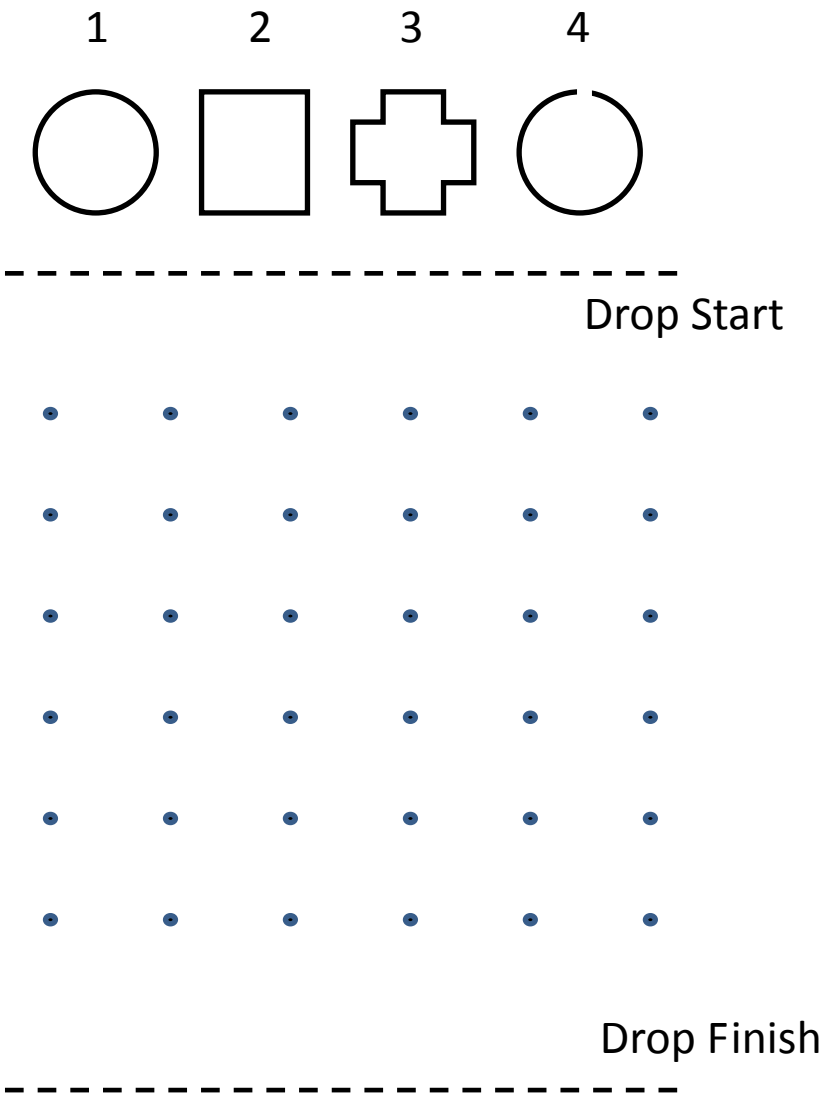
15. The following diagram shows a loop of wire towards which a magnet is moved in the direction shown.



A correct statement is that;

(A) An emf will not be induced in the loop because it is a closed circuit
(B) An anticlockwise emf will be established in the loop
(C) A clockwise emf will be established in the loop due to the changing magnetic field of the bar magnet
(D) The magnetic flux density due to the bar magnet at its poles will remain constant

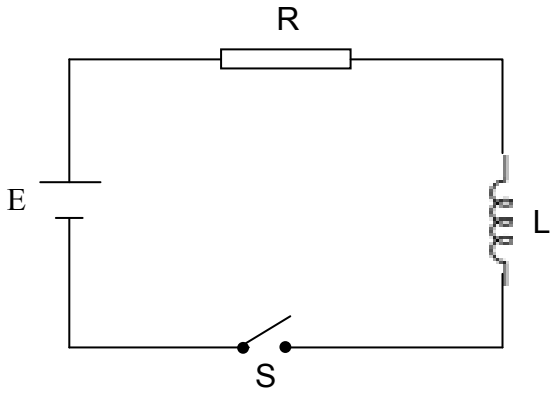
16. Four copper wires of different shapes (each with a mass of 2g) are dropped simultaneously through a constant magnetic field of 2 T.



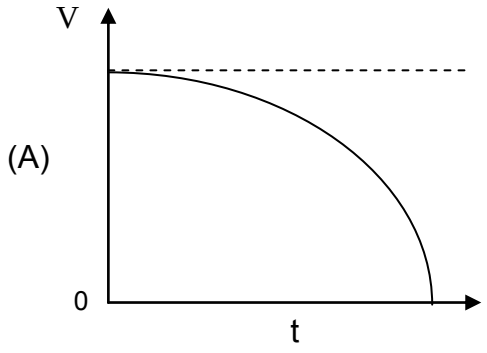
In which order will the objects hit the floor?

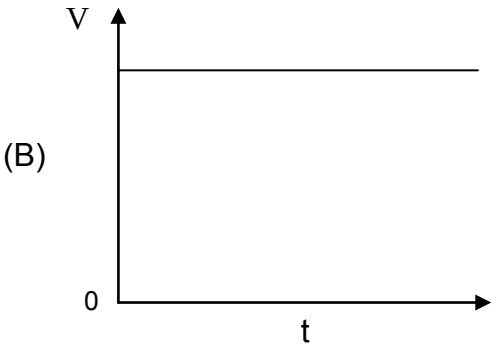
(A) 4 3 2 1
(B) 1 2 3 4
(C) 4 3 1 2
(D) 3 2 1 4

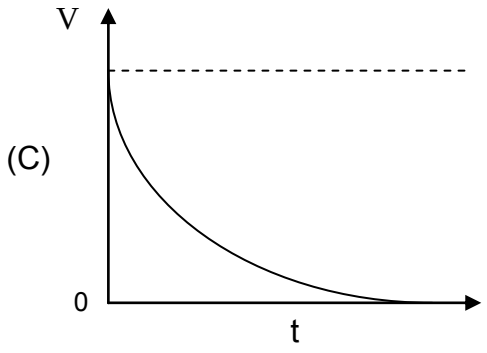
17. In the diagram below, the switch S is closed at time t = 0 such that a current flows through a circuit that consists of a resistor (R) in series with a coil (L).

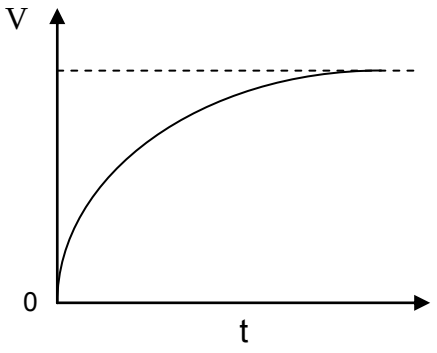


Which of the following diagrams best represents the potential difference (V) across the resistor as seen on an oscilloscope?







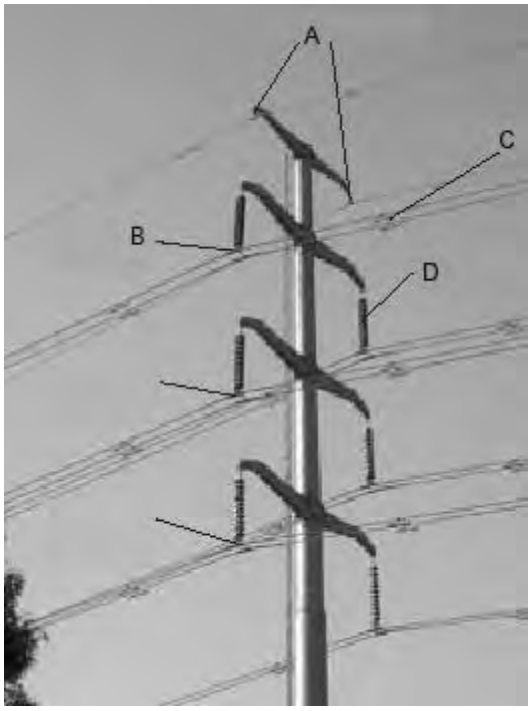


18. Transformers played a critical role in “the war of currents” between Edison and Westinghouse.

Which statement best explains the impact of transformers.

(A) Transformers allowed lower voltages to be supplied to households
(B) Transformers converted DC current to AC current
(C) Transformers converted AC current to DC current
(D) Transformers reduced the current coming from power stations

19. The diagram shows high voltage transmission lines. The letters that represent shield conductors and chain insulators are;



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

20. Which statement best identifies a disadvantage of Induction Cooktops.

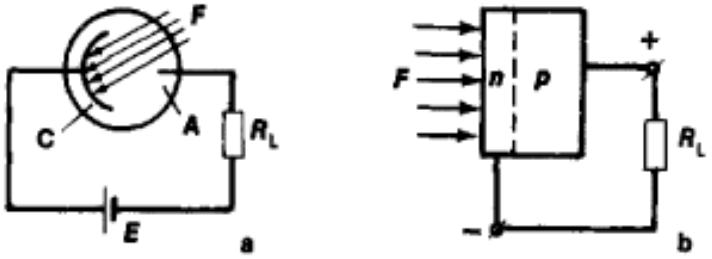
(A) The great number of components cause more power losses
(B) They can cause burns to people wearing metal jewellery
(C) The heat transferred depends on the type of pot or pan used
(D) The great number of components leads to high costs

Section 1: Part B – Nine Free Response Questions: Answer All Questions

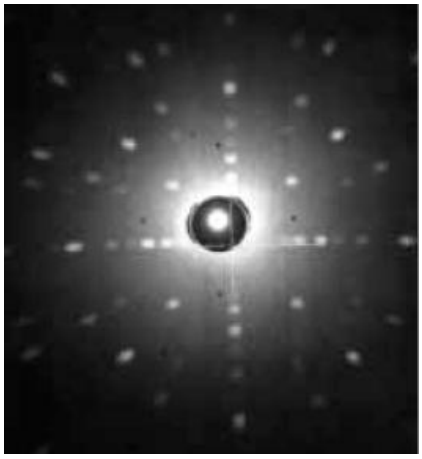
21. Both Solar cells and Photocells use the transformation of light energy to electron kinetic energy (H7).

a) Calculate the energy that a 1024 nm photon can transmit to an electron. 2m

b) Construct a table to compare the structure and function of Solar Cells and Photocells. Ensure you refer to the diagrams below in your response (H10). 5m



22. The following image is a typical x-ray diffraction pattern of a metallic crystal (14.1g, 14.3b).



a) Outline the significance of the findings of the Bragg experiments to our development of a model for semiconductors. 3m

b) Clarify how this increased knowledge of the properties of materials was important to the invention of the transistor. 3m

23. The image below shows a magnet hovering above a superconductor that has become superconducting (14.3b, H9).

a) Use your knowledge of superconductivity to explain the phenomenon. 3m

b) Identify and justify one reason why the magnet may cease hovering. 3m

24. a) Explain the concept of a gravitational field. (H9) 2m

b) Justify factors that are understood to affect the strength of a gravitational field. (H9) 3m

25. A rocket of mass 7500 kg is launched from the Earth‟s surface into a uniform circular orbit of radius 7.5×10^6 m. (14.1f)

http://www.aerospaceguide.net/spacerocket/aresv.html

a) Calculate the magnitude of the gravitational potential energy when the rocket is in this orbit. 2m

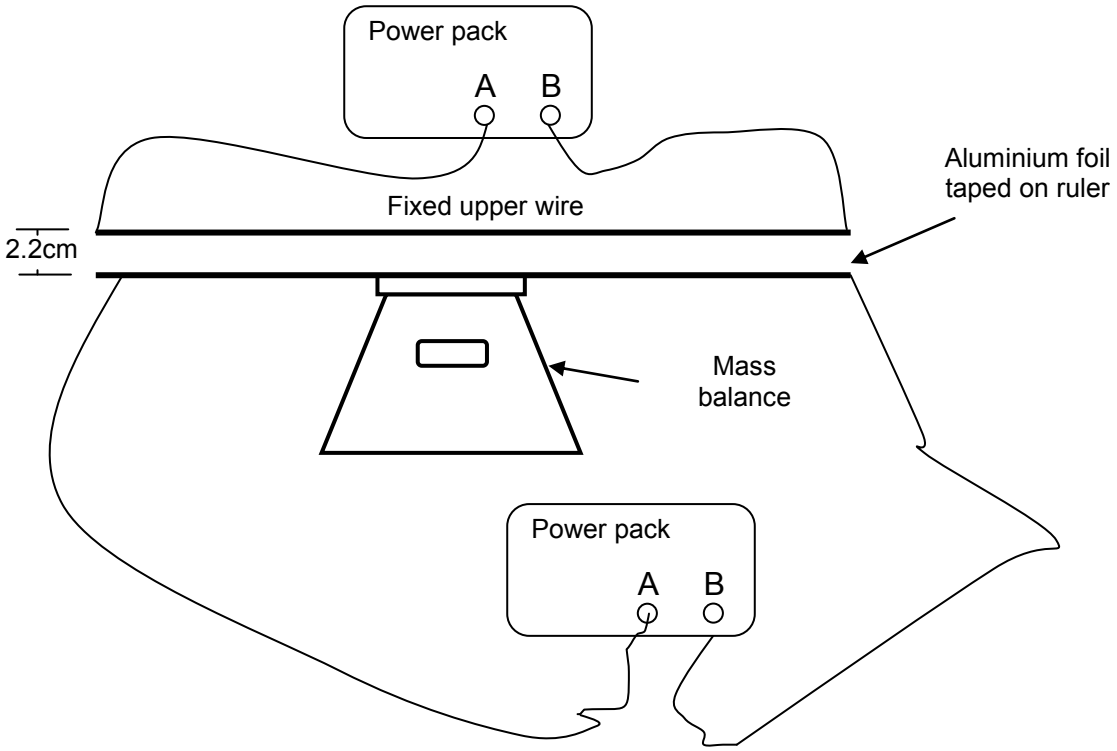
b) The rocket can escape Earth‟s gravitational field from this orbit when its kinetic energy is equal to the magnitude of the gravitational potential energy.

Use this relationship to calculate the escape velocity of the rocket. 3m

26. Two students conducted an experiment to determine the value of the constant K in the equation which describes the force between two parallel current-carrying conductors; ie

$$\frac{F}{l} = K\frac{i_1 i_2}{d}$$

Two „wires" made from aluminium foil, each of length 60.0cm, were fastened to two wooden rulers using sticky tape. The upper wire was fixed horizontally using a retort stand. The lower wire was placed on a digital mass balance. The wires were parallel to each other, separated by 2.2 cm and current was passed through them. The direction of the currents ensured that both wires experienced repulsion.

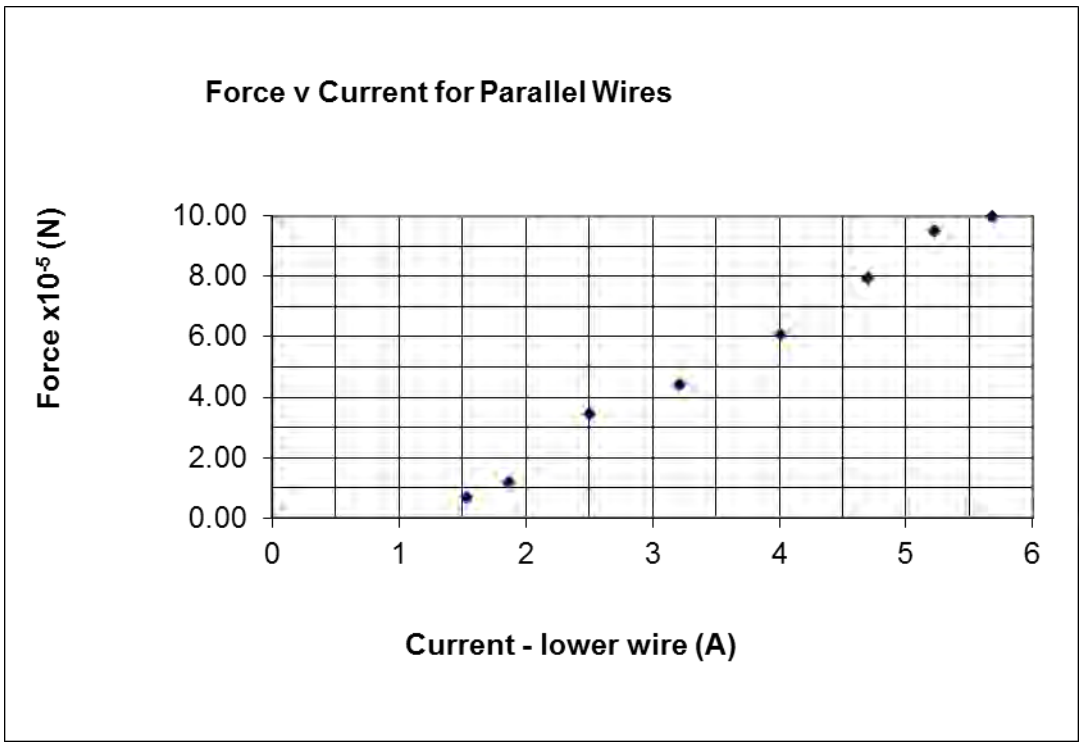


The current in the fixed upper wire was varied while the current in the lower wire that rested on a tared digital scale was held constant at 2.70 amps. The force of repulsion between the wires resulted in a gain of apparent mass for the lower wire. This mass gain was translated into an apparent force. (11.2a, 12.3c, 13.1d)

1m

a) Mark on the diagram the directions the currents in the two wires might flow so the two wires experience a repulsive force.

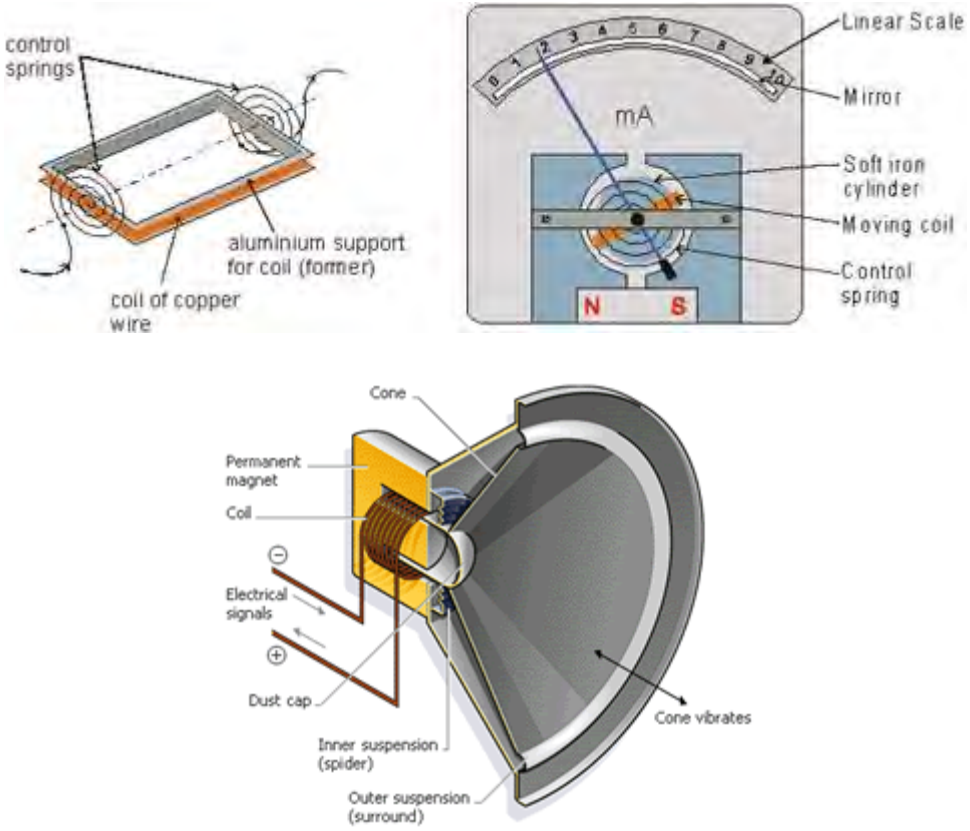
The students recorded their results and produced the following graph.



b) Draw a line of best fit and use your calculated gradient to solve for the constant K. (13.1g) 4m

c) Clarify how this experiment tests and validates a model that you have used to explain magnetic interactions. (12.4de) 3m

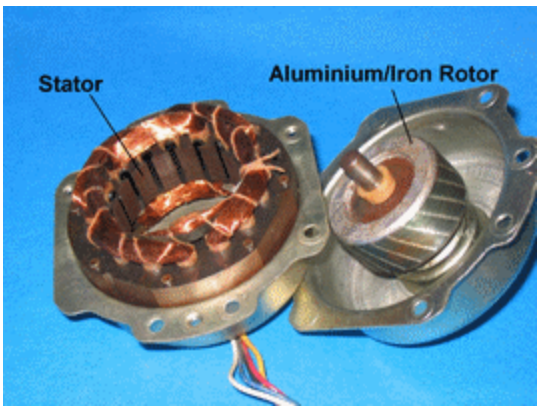
27. In your studies you researched data sources on the application of the motor effect in the galvanometer or loudspeaker (H9).



http://www.school-for-champions.com/science/electromagnetic_devices.htm

Outline how the current supplied to your choice of device causes its operation. 3m

28. During your study you investigated the principles of an AC induction motor. (H9)



Provide an explanation relevant to the operation of an AC induction motor how a moving magnetic field passing over a conductor causes a force. 3m

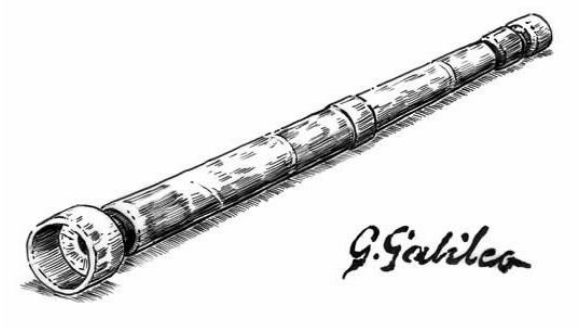
29. For two appliances used in the home, recommend with justification the use of different types of electrical motors (H9). 2m

Section II: Question 30 Astrophysics – 35 Marks

Free Response Questions: Answer All Questions

Allow about 65 minutes for this section

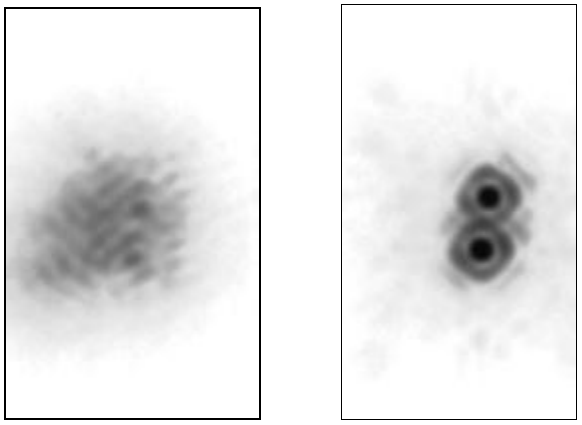
(a) (i) This is a sketch Galileo made of his telescope. (H1)



The aperture of Galileo‟s telescope was 4 cm.
Outline why this aperture diameter limited the sensitivity and resolution of the image. 4m

(ii) Outline the problems associated with ground-based astronomy in terms of resolution, absorption of radiation and atmospheric distortion. 3m

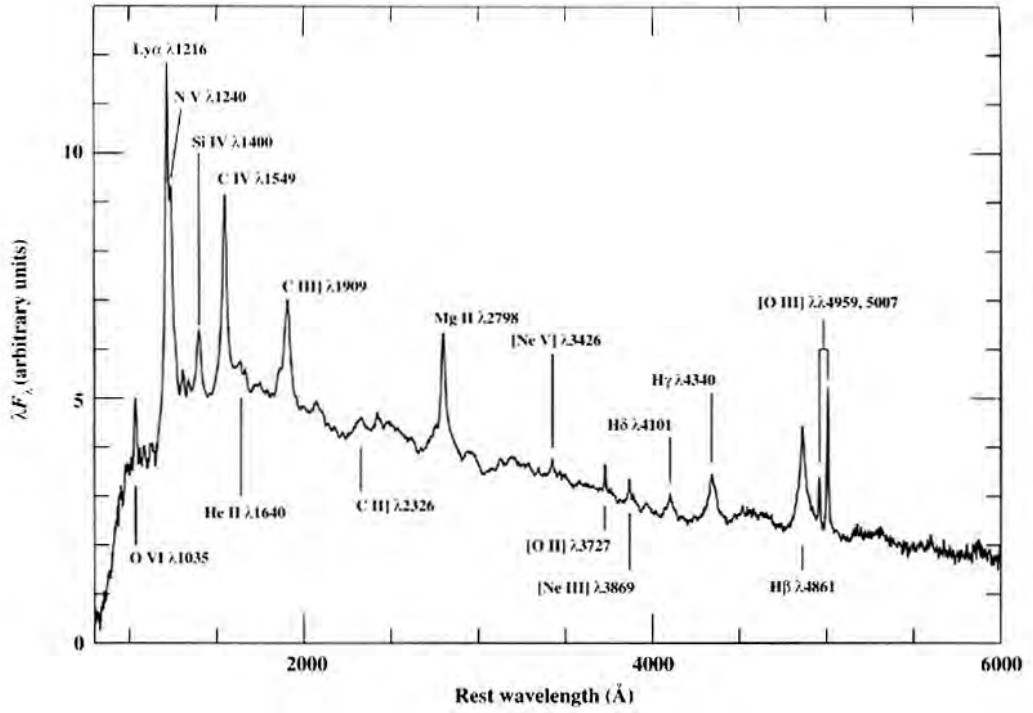
(iii) The left image transformed to the right image when the telescope's active and adaptive optical systems were activated. 4m



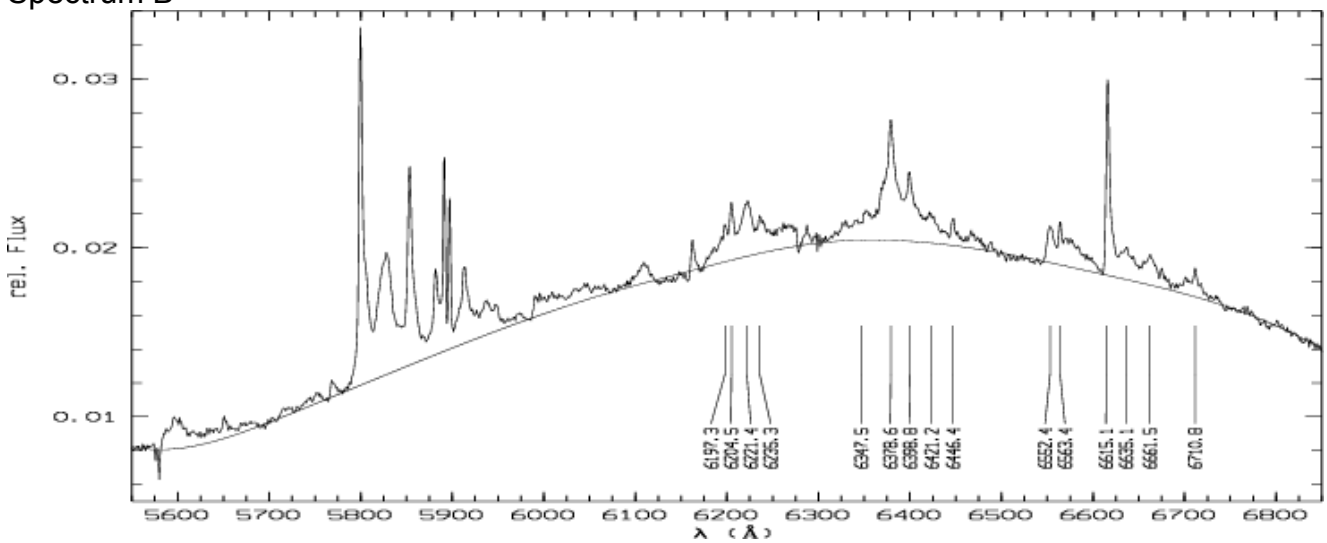
Distinguish between active and adaptive optics.

(b) (i) The four images that follow are spectra produced by stars, emission nebulae, galaxies and quasars. (12.3c,14.1a, 14.3b)
Identify which spectrum is of a star, emission nebula, galaxy or quasar. 4m

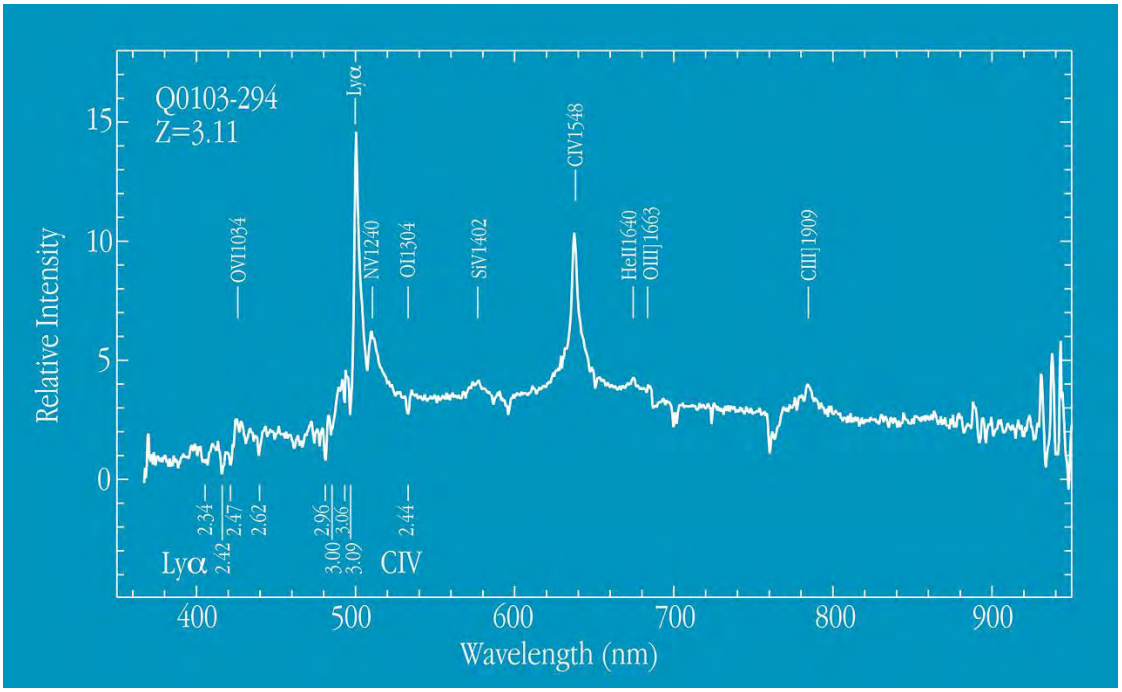
Spectrum A



Spectrum B

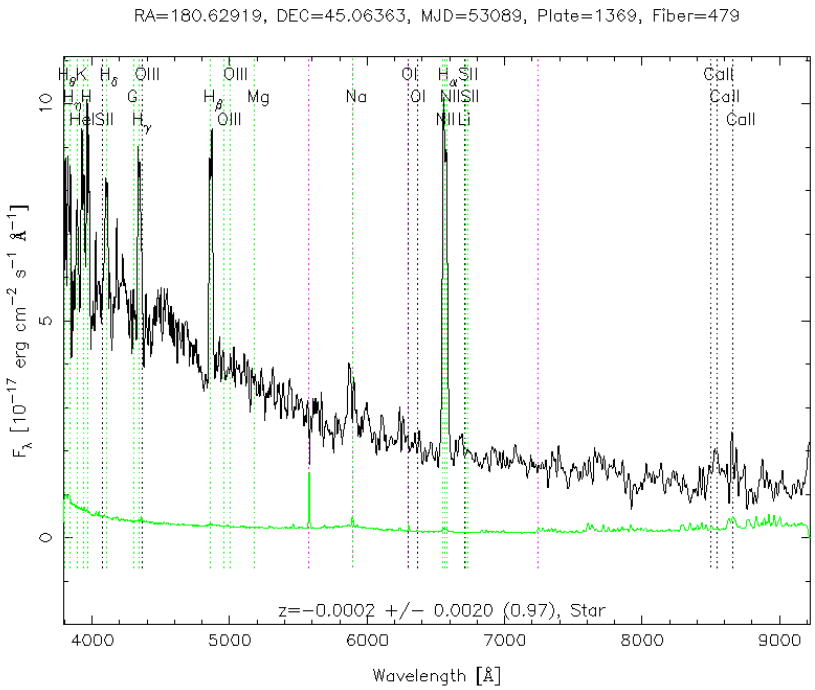


Spectrum C



http://www.eso.org/public/archives/images/screen/eso9920r.jpg

Spectrum D



Spectrum A: _____

Spectrum B: _____

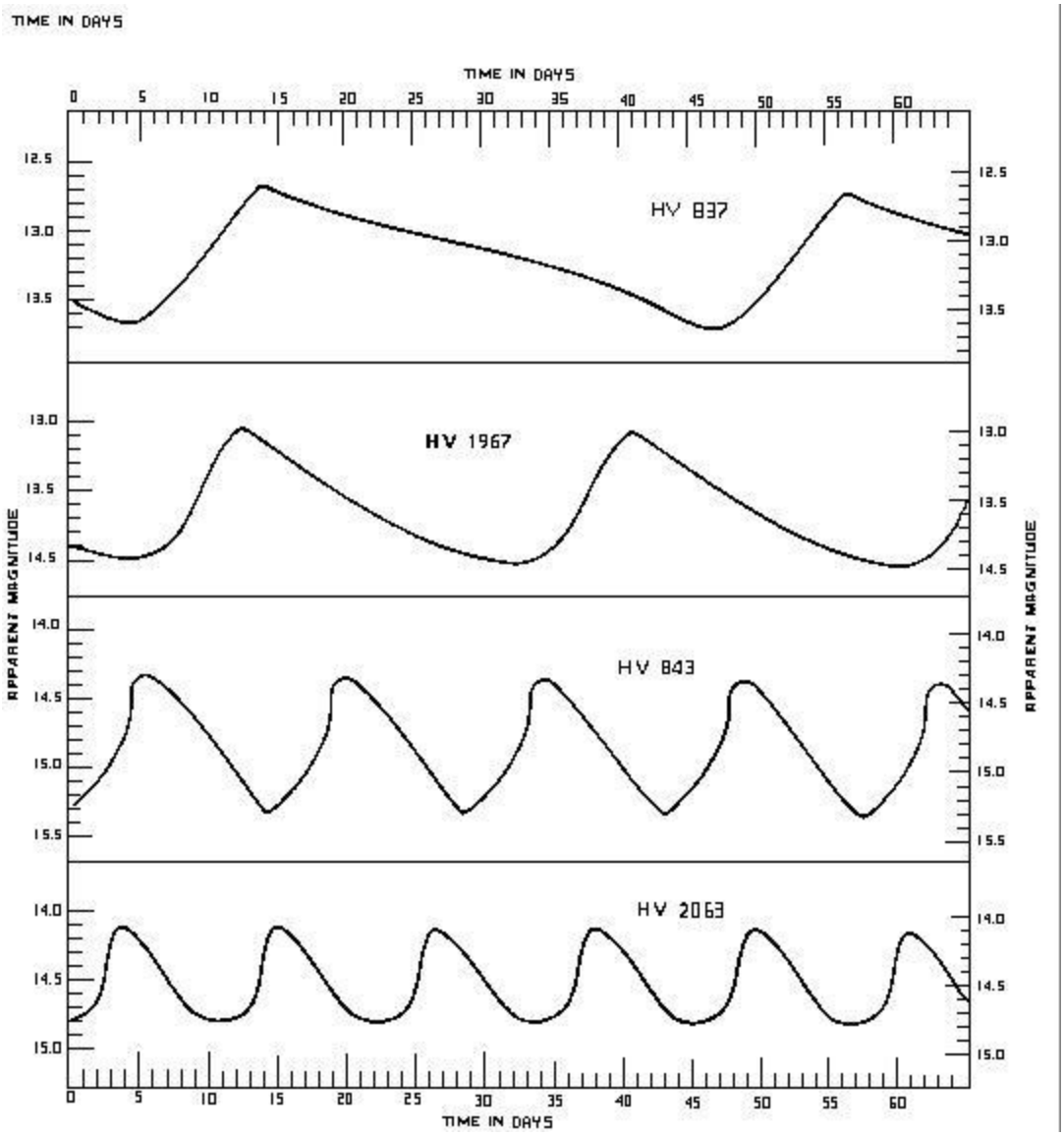
Spectrum C: _____

Spectrum D: _____

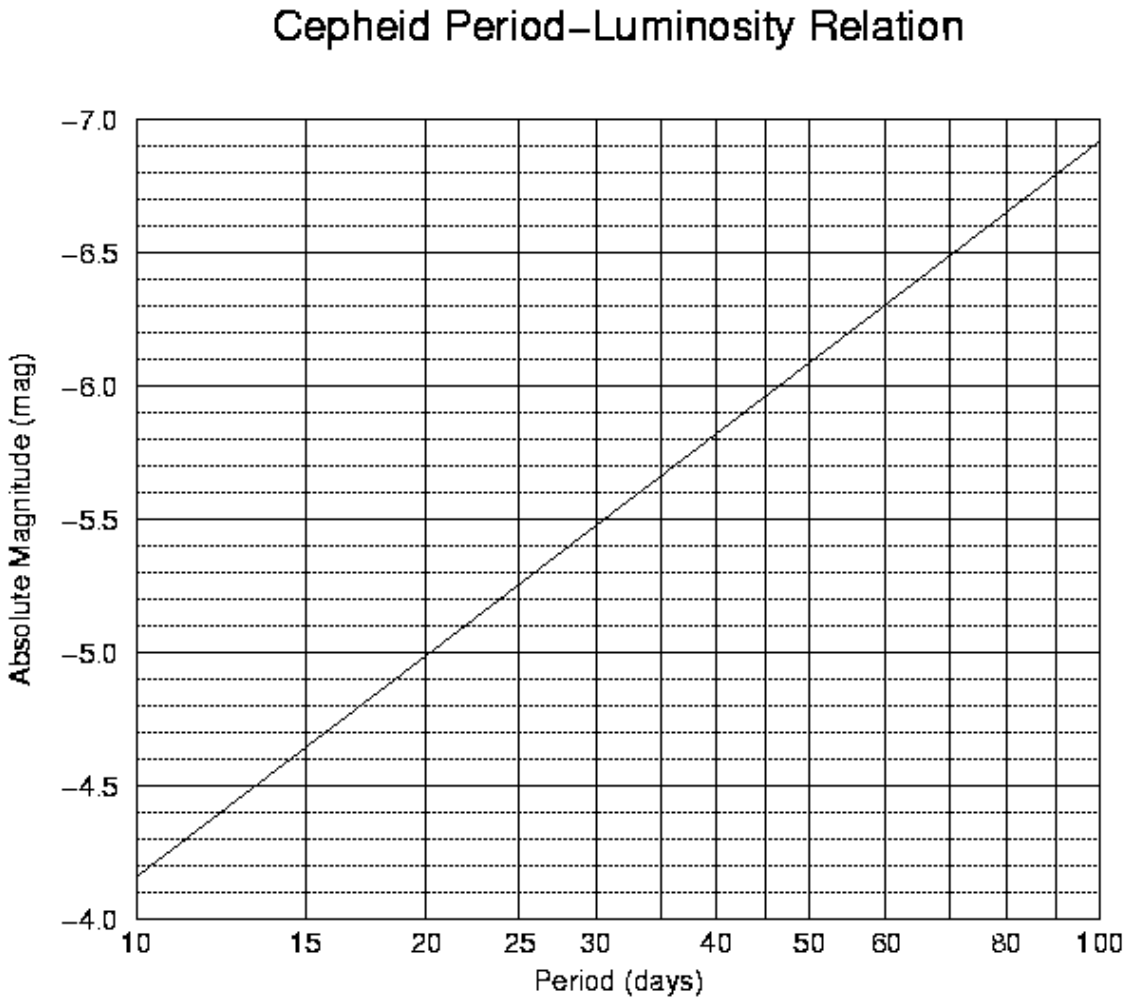
(ii) Describe three key features of stellar spectra and describe how these are used to classify stars. 4m

(iii) Describe how spectra can provide information on rotational and translational velocity, and density of stars. 4m

(c) The following diagram shows the periodicity of some Cepheids in the Small Magellanic Cloud. (14.1f) 4m



Use the graphs that follow to assist you to determine the distance to HV 2063.


Cepheid Period–Luminosity Relation
Absolute Magnitude (mag)
−7.0
−6.5
−6.0
−5.5
−5.0
−4.5
−4.0
10
15
20
25
30
40
50
60
80
100
Period (days)

(d) The image that follows is a globular cluster (13.1e,f).

(i) Distinguish between an open cluster and a globular cluster. 3m

(ii) Use plots of the HR diagram a part of your explanation as to how the age of a globular cluster can be determined from its zero-age main sequence plot for an H-R diagram. 5m

End of Exam