TRIAL HIGHER SCHOOL
CERTIFICATE EXAMINATION 2001

Physics

Examination Author—
S Robinson, B Sc, Dip Ed, Cert Gifted Ed

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using a blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Formula Sheets are provided at the back of this paper
- Answer Part A questions on a Part A Answer Sheet (not supplied).
- Answer Part B questions in the spaces provided in this Book.
- Answer the Option you choose from Section II in a Writing Book (not supplied).

Section I CORE Pages 2 – 18

Total marks **75**
This section has two parts, Part A and Part B

Part A
Total marks **15**
- Attempt Questions 1 – 15
- Allow about 30 minutes for this part

Part B
Total marks **60**
- Attempt Questions 16 – 27
- Allow about 1 hour 45 minutes for this part.

Section II OPTIONS Pages 18 – 26

Total marks **25**
- Attempt ONE question from Questions 28 – 32
- Allow about 45 minutes for this section

Trial Higher School
Certificate Examination ***2001***

Physics

by S Robinson, B Sc, Dip Ed, Cert Gifted Ed

Section I
Total marks (75)

Part A
Total marks (15)
Attempt questions 1 to 15
Allow about 30 minutes for this part

Use the multiple choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample $2 + 4 =$

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

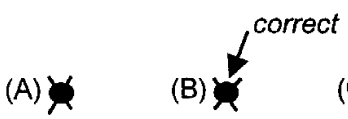
Sample Answer

(A) ○ (B) ● (C) ○ (D) ○

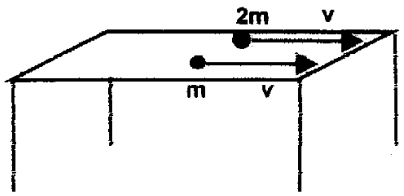
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(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:



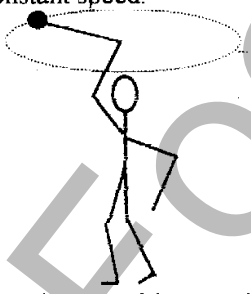
1 A student pushes two small spheres of masses **m** and **2m** so they leave the table with the **same** horizontal velocity **v** as shown:-



Assuming that air friction is negligible

(A) the lighter sphere will hit the ground twice as far from the table as the heavier sphere
(B) the heavier sphere will hit the ground twice as far from the table as the lighter sphere
(C) the lighter sphere will hit the ground further from the table than the heavier sphere, but not twice as far
(D) the two spheres will hit the ground the same distance from the table

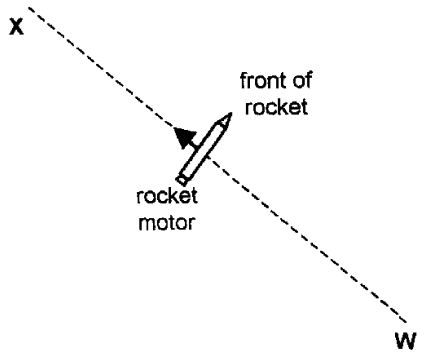
2 If you tie an object to a piece of string, then swing the object in a circle around your head, the string provides a **force** on the object and the object can be swung in a circle at constant speed.



For a satellite in a geostationary orbit around the earth,

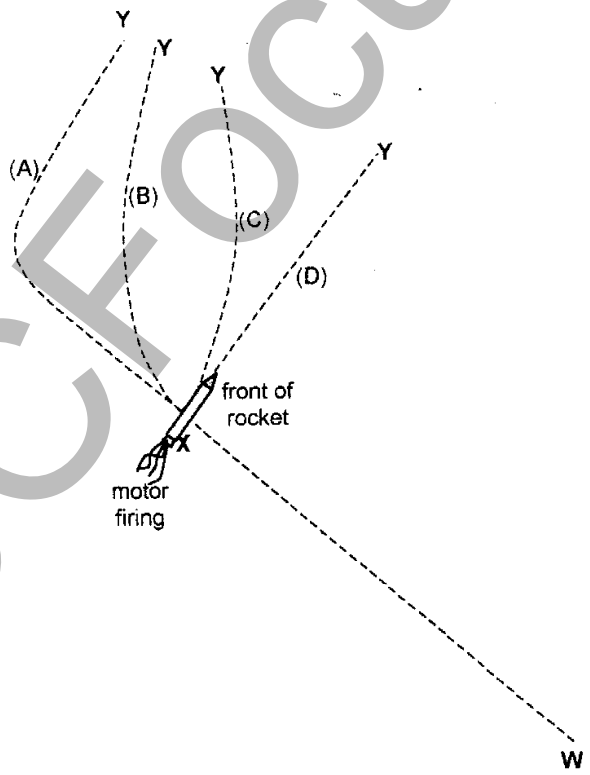
(A) there is no similar force needed, because the satellite is "stationary" above the same point on earth
(B) the needed force is provided by the thrusters on the satellite
(C) the needed force is provided by the tiny amount of air friction that exists even at that height
(D) the needed force is provided the gravitational attraction between the satellite and the earth

3 A rocket is drifting in space along a path from **W** to **X** and is pointing in a direction at right angles to the path, as shown:-

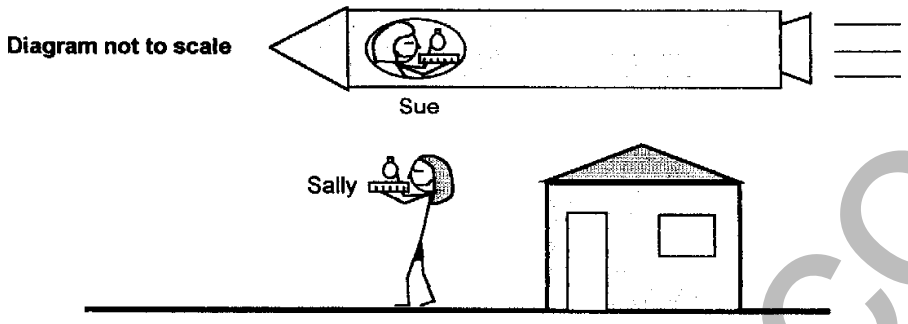


When the rocket reaches point **X**, the rocket motor is fired for a short time straight ahead (in the direction the rocket is pointing), until the rocket reaches point **Y**, when the motor is turned off. Assume that the rocket motor produces constant thrust (force) while going from **X** to **Y**, and that only a very tiny amount of fuel is used.

Which path would the rocket follow in getting from **X** to **Y**?



4 If Sue were to fly past Sally in a rocket at a **very high** constant relative velocity,

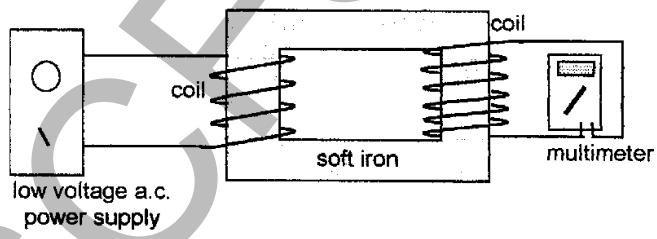


then, by Einstein's Theory of Special Relativity, Sally would observe Sue's clock as running slower than her own.

Sue would see the situation as follows:-

(A) Sally's clock would appear to run faster than her own, and Sally's ruler would appear longer than her own
(B) Sally's clock would appear to run faster than her own, but Sally's ruler, being solid, would appear the same as her own
(C) Sally's clock would appear to run slower than her own, but Sally's ruler, being solid, would appear the same as her own
(D) Sally's clock would appear to run slower than her own, and Sally's ruler would appear shorter than her own

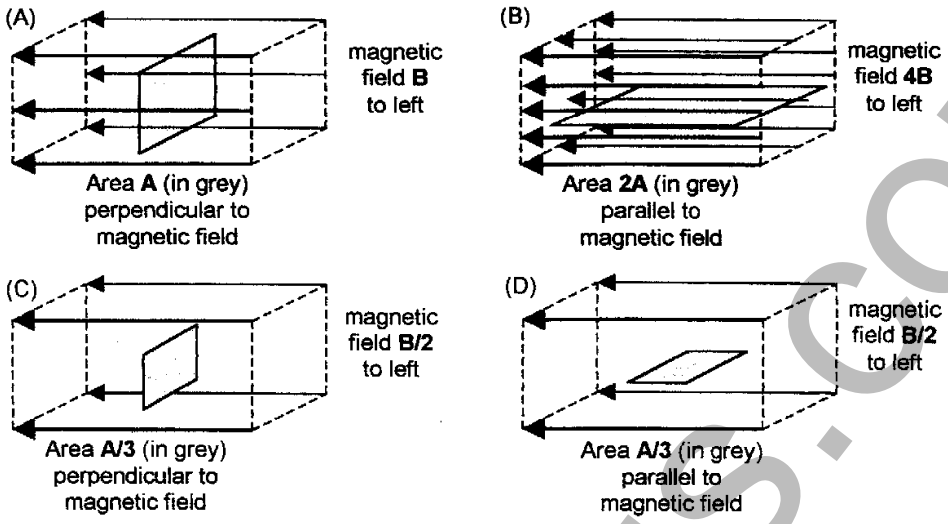
5 A student set up the following equipment:-



The student was planning to demonstrate

(A) magnetic braking
(B) Faraday's initial discovery of electromagnetic induction
(C) how a transformer works
(D) how an induction motor works

6 In which of the following is the magnetic flux greatest through the area shaded in grey?



7 Which of the following is NOT a necessary component of an AC generator?

(A) a magnetic field
(B) a coil or loop of conducting material
(C) a commutator
(D) a change in magnetic flux through the coil or loop

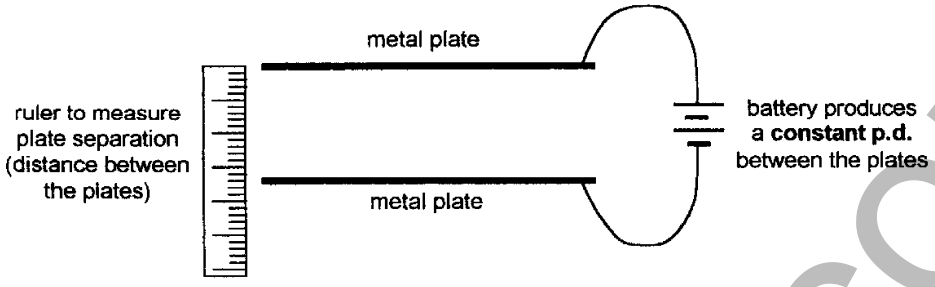
8 In many step-up transformers, the core is made from thin laminations of steel. This is done

(A) to reduce costs because thin laminations are cheaper than a lump of steel
(B) to reduce energy losses from eddy currents
(C) so the transformer can increase both the current and the voltage
(D) so they won't shatter if dropped

9 Electric motors in appliances such as Video Cassette Recorders, CD players and computer cooling fans are usually AC inductions motors because

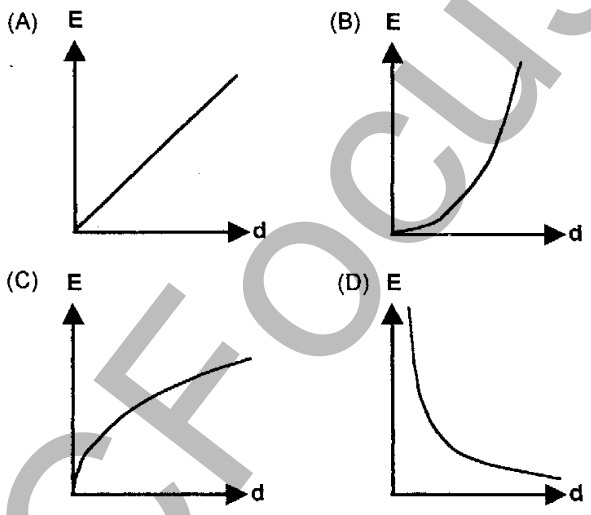
(A) there are no brushes to wear out
(B) there are no ozone-producing sparks
(C) they are simple and cheap to make
(D) all of the above

10 A student set up the following equipment to investigate the electric field strength **E** between two parallel charged plates as their separation **d** was varied:-



She measured the electric field strength **E** for different values of plate separation **d**, then plotted **E** against **d**.

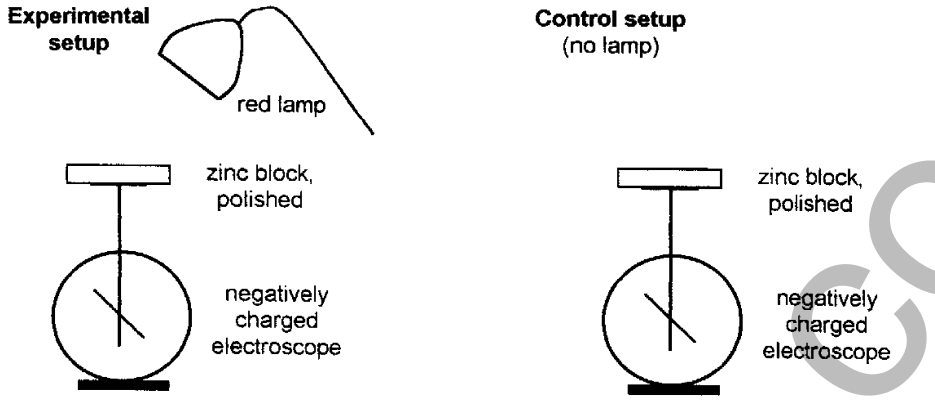
Which of the following was the graph she produced, assuming her experimental technique was good?



11 The idea that the stable "orbits" of electrons in atoms can be explained by assuming that electrons have a wave nature and form standing waves within the atom, was proposed by

(A) de Broglie
(B) Einstein
(C) Hertz
(D) Planck

12 A student tried to demonstrate the photoelectric effect using the following setup:-



He took two identical electroscopes and on each placed a polished zinc block. He then charged each with the same amount of negative charge. He shone a bright red light on one of them.

He reasoned that the light should knock electrons out of the zinc, so the one under the light should discharge faster than the other.

When he tried it, he found to his surprise that both electroscopes appeared to discharge at the same rate.

You advise him that his experiment is more likely to work if

(A) he uses a brighter red light
(B) he moves the light closer to the zinc
(C) he starts with both electroscopes charged positively
(D) he uses a light of higher frequency

13 In 1915 the father and son team of William Henry Bragg and William Lawrence Bragg were awarded the Nobel Prize for Physics, for the value of their contribution to the study of crystal structures by means of

(A) diffraction/interference patterns of X-rays interacting with planes of atoms
(B) polarisation of light passing through planes of atoms
(C) pairing of electrons passing through crystals
(D) doping to produce "p" and "n" type semiconductors

14 When you enter a dark room and switch on the lights, the lights seem to come on instantaneously, even though they may be many metres from the switch. They light up so rapidly because

(A) although the drift velocity of electrons in the wires is only a few millimetres per second, the electric field (set up by closing the switch) immediately causes the free electrons that were already in the filament of the bulb to start moving
(B) the wires to the bulb are initially superconducting, but the magnetic field produced by the moving electrons soon stops the superconductivity
(C) initially the drift velocity of the electrons in the wires is almost infinite, although as the bulb heats up it reduces this to a few millimetres per second
(D) the de Broglie wave nature of electrons means that they always move at the speed of light

15 Peter was investigating the relationship between net force, mass and acceleration. He applied different values of net force to a constant mass on an air track, and measured the acceleration in each case. In his investigation, the **dependent variable**, the **independent variable** and the **controlled variable** were respectively

(A) net force, acceleration, mass
(B) net force, mass, acceleration
(C) acceleration, net force, mass
(D) acceleration, mass, net force

Section 1 **Marks**

Part B
Total marks (60)
Attempt questions 16 to 27
Allow about 1 hour and 45 minutes for this part

Answer each question in the space allowed in this booklet.

Show all relevant working in questions involving calculations.

Question 16 (9 marks)

Two students were investigating an experimental circuit where the current **I** through a particular circuit element was found to depend on two variables **p** and **q**.

They kept variable **q** constant, and then investigated how **I** depended on variable **p** alone. They obtained the following data:-

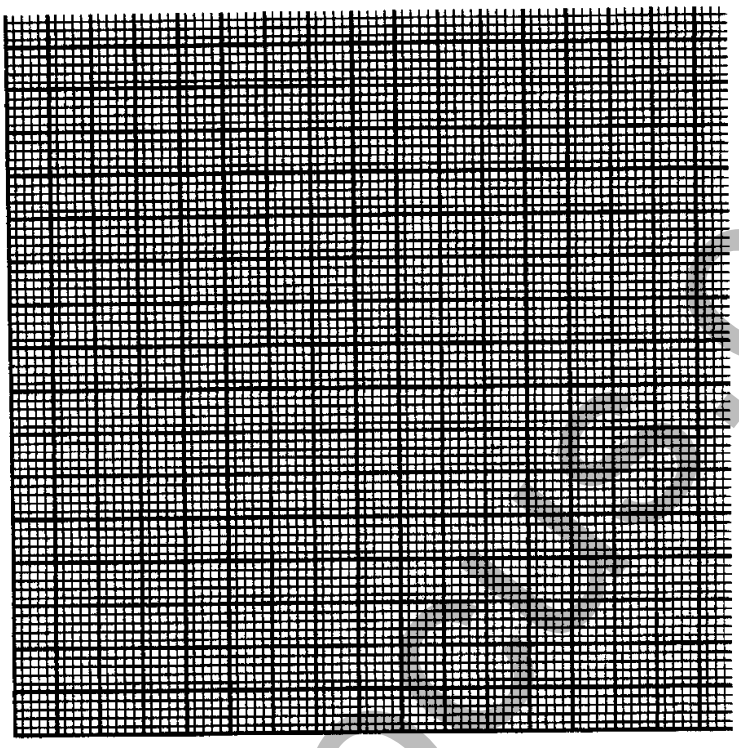
variable p (m^{-1})	**current I** (A)
0.0	0.0
1.3	0.5
2.4	1.6
2.9	2.3
3.4	3.2
5.0	6.9
7.1	13.8

(a) Why did they keep variable **q** at a constant value when doing their experiment? **1**

Question 16 continues on the next page

Question 16, continued

(b) Graph **I** against variable **p** 4



The students felt that the graph suggested that **I** was proportional to $\mathbf{p}^2$.

(c) What feature of the graph would make them suspect that **I** is proportional to $\mathbf{p}^2$? 1

(d) The graph alone does not prove that **I** is proportional to $\mathbf{p}^2$. Explain why not. 1

(e) What additional graph should they plot to check if **I** is indeed proportional to $\mathbf{p}^2$? What sort of line/curve would they then expect if **I** is proportional to $\mathbf{p}^2$?(Do not draw the graph, just state what should be plotted against what, and what result would be expected.) 2

Question 17 (2 marks) **Marks**

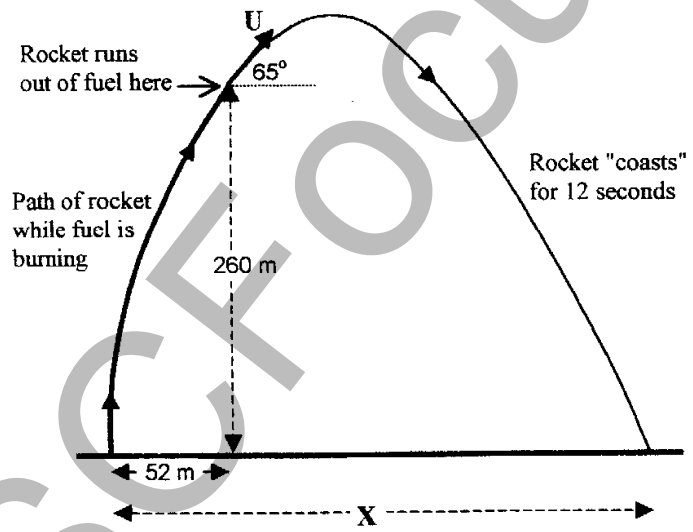
An astronaut on earth has a weight of 686N, but the astronaut's weight on the moon is only 112 N.

What is the value of "g" on the moon? **2**

Question 18 (6 marks)

A group of students build a small rocket under the guidance of an expert, and take it out to a large field to test it. It takes off vertically, but does not go quite straight, as shown in the diagram.

At a height of 260 m it runs out of fuel. At that point it is travelling at an angle of 65 degrees to the horizontal as shown. It then coasts on, following a path somewhat like the one shown, hitting the ground 12s after it ran out of fuel.
Note that the diagram is NOT to scale.



For the following parts (a) and (b), assume that air friction on the rocket is not significant.

(a) What was the speed U (see diagram) of the rocket at the point where it ran out of fuel? **2**

Question 18 continues on the next page

Question 18, continued:- **Marks**

(b) What is the distance **X** (see diagram) from the launch point to where it hits the ground? **2**

(c) Explain why the approach that you used above to calculate speed [part (a)] and distance [part (b)] could not be used for a rocket that went to a height of 100 kilometres before running out of fuel, even if air friction were negligible for that rocket. **1**

(d) Sites for launching satellites are generally close to the equator. When a low earth orbit satellite with an orbit close to the equator is launched from such a site, the rocket carrying it will initially climb vertically upwards, but will then be steered towards the East. Explain why this is a preferred direction, rather than towards the West. **1**

Question 19 (3 marks)

The Moon orbits the Earth with a period of 27.3 days (measured with respect to the background stars).

(a) Calculate the radius of the Moon's orbit. **2**

(b) The accepted value for the radius of the moon's orbit is 3.844×10^8 m. Why would your answer to (a) differ from this? **1**

Question 20 (4 marks)

Marks

(a) Describe the experimental set-up and procedure used by Michelson and Morley to measure the relative velocity of the earth through the aether. **2**

(b) Evaluate the importance of the results of this experiment. **2**

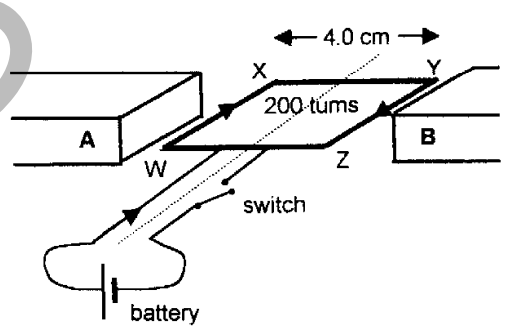
Question 21 (2 marks)

Many charged particles travelling at high speed approach earth from space, but few reach the earth's surface, because they are "trapped" in the Van Allen radiation belts. Describe how this "trapping" occurs. **2**

Question 22 (9 marks)

A square coil of wire WXYZ of 200 turns is placed between two magnetic poles A and B of opposite polarity. The coil is able to rotate about an axis shown by the dotted line in the diagram. The length of side WX = XY = YZ = ZW = 4.0 cm.

The ends of the coil are connected to a battery and switch as shown. When the switch is closed, the coil starts to rotate anticlockwise about the axis when viewed from the front as shown.



Question 22 continues on the next page

Question 22, continued

Marks

(a) Which of A or B is a magnetic north pole? _____ **1**

(b) The coil will rotate less than half a turn before coming to a stop. Explain why. **2**

_____

_____

_____

_____

(c) In order to convert this device into an electric motor that will keep on rotating, a commutator must be added. How does the commutator help? **2**

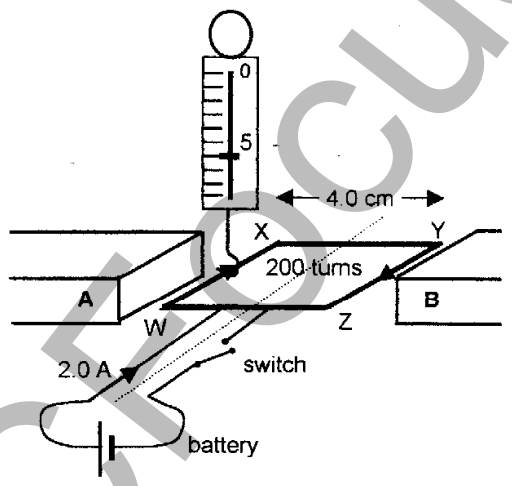
_____

_____

_____

_____

(d) If a spring balance is hooked on to the side WX as shown, it just stops the coil from rotating with the switch closed when the spring balance reads 6.0 N, when a current of 2.0 A is flowing from the battery.



What is the torque on the coil applied by the spring balance? **2**

_____

_____

_____

_____

(e) What is the strength of the magnetic field that the coil is in? **2**

_____

_____

_____

_____

Question 23 (4 marks)

Marks

In August 1831 Michael Faraday discovered the principle of electromagnetic induction. He was doing what would now be called "pure research" (research driven by curiosity about how the world worked).

Assess the impact of Faraday's work on electromagnetic induction on the development of technologies. **4**

Question 24 (3 marks)

The first commercial electrical power plants produced DC. However the superiority of AC soon became apparent, and large scale electrical supply systems are now nearly all AC.

(a) Why is AC preferable to DC for the **generation** of electrical energy? **1**

(b) Why is AC preferable to DC for the **distribution** of electrical energy? **2**

Question 25 (4 marks)

(a) Describe in detail the operation of a solar cell. Include references to the formation of an electric field and the part that the photoelectric effect plays in the operation of the cell. **3**

Question 25 continues on the next page

Marks

(b) A photon of light has a wavelength of 5.0×10^{-7} m. What is its frequency? **1**

Question 26 (4 marks)

(a) Describe how doping can produce p-type silicon. **2**

(b) Describe how electric charge moves in a piece of p-type silicon when an electric field is placed across it. **2**

Question 27 (10 marks)

(a) Describe a first hand investigation that you have done to investigate the heating effects of electric current in a range of conductors. **5**

Question 27 continues on the next page

Question 27, continued

Marks

(b) Superconductors offer a way of eliminating heating effects in many applications. Evaluate the usefulness of using superconductors to eliminate energy losses in different applications.

5

Section II - Options

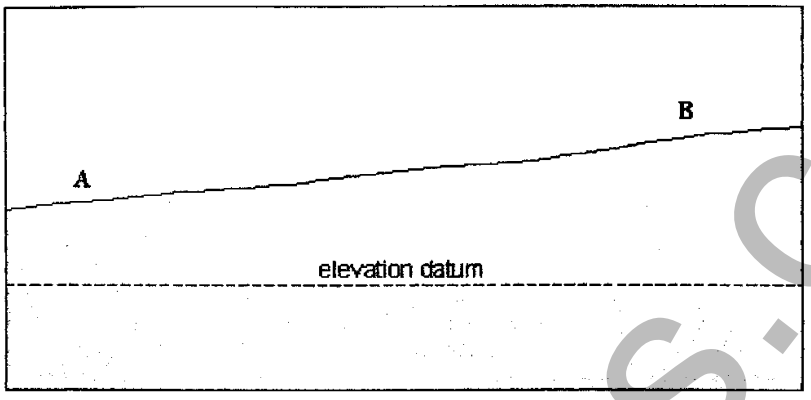
Total marks (25)
Attempt ONE question from Questions 28 to 32
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra booklets are available.

Show all relevant working in questions involving calculations.

Question 28 – Geophysics (25 marks) **Marks**

(a) A geologist looking for an ore body beneath the earth's surface makes a number of observations in a gravimetric survey. Two of the observation points are A and B shown below:-



Before the results from A and B can be meaningfully compared, they must be "reduced" to a common "level", the elevation datum.

List **three** corrections that must be applied to the gravity readings at each site before they can be meaningfully compared, and for each explain why the correction is necessary. **4**

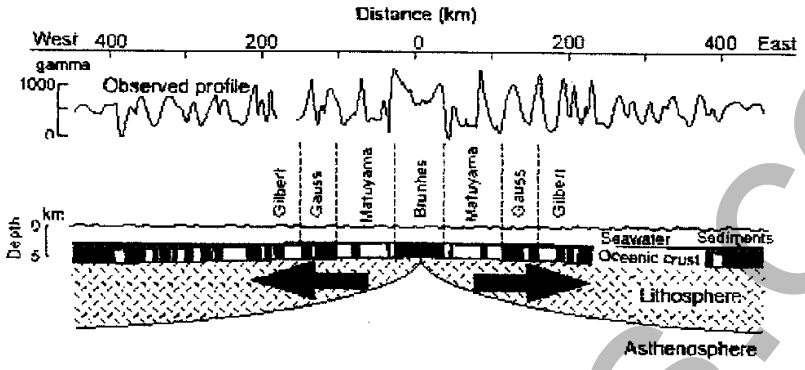
(b) The LAGEOS satellite has a period of 13673.5 s and a mean orbital radius of 12265 km. From these data calculate the mass of the earth. **2**

Question 28 continues on the next page:-

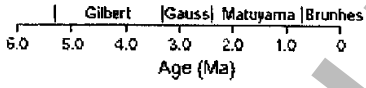
Question 28 (Geophysics), continued

Marks

(c) The diagram below shows magnetic reversals in the ocean floor across part of the Pacific-Antarctic Ridge. Black bands represent normal polarity, and white bands reversed polarity.



Also shown is a time scale of various epochs ("Ma" = Million years ago):-



(i) How many periods of magnetic reversal have there been in the last 3.3 million years? **1**

(ii) Approximately when was the middle of the **longest** period of magnetic **reversal** shown? **1**

(iii) Calculate the approximate average rate of sea floor spreading from these data. Show working clearly. **3**

(d) Explain how geophysicists have deduced that the outer core of the earth is liquid. **2**

(e) Evaluate the contribution that geophysical techniques have made to exploration geology. Look at four different techniques in your answer. **12**

Question 29 -- Medical Physics (25 marks) **Marks**

(a) (i) explain what is meant by coherent and incoherent bundles of fibres in an endoscope, and then discuss the role of each. **3**

(ii) how can an endoscope "see around corners" when examining something inside a person? Make sure that you explain the physics involved in the light "going around corners". **2**

(b) The speed of sound in soft tissue is about 1540 ms^{-1}. The acoustic impedance of muscle is about 1.64 x 10^6 kg m^{-2} s^{-1}, and the acoustic impedance of bone is about 7.68 x 10^6 kg m^{-2} s^{-1}.

(i) If a diagnostic ultrasound pulse is directed perpendicularly towards a muscle/bone interface, what percentage of the incoming intensity will be reflected? **2**

(ii) What is the density of muscle tissue from these figures? **2**

(c) Below is a list of compounds used in PET scans. The list came from a manufacturer's catalogue.

"Fluoro-18-deoxyglucose (F.D.G.) to study glucose metabolism.
Carbon-11-methionine for visualizing and measuring tumor metabolic activity.
Carbon-11-carbon monoxide for measuring tumor blood volume.
Oxygen-15-water.
Nitrogen-13-ammonia."

Here also is a list of half-lives from the same catalogue.

"Carbon-11 (half-life 20 min).
Nitrogen-13 (half-life 10 min).
Oxygen-15 (half-life 2 min).
Fluorine-18 (half-life 110 min)."

(i) Explain what is meant by "Oxygen-15-water" **1**

(ii) Methionine is an amino acid needed for protein synthesis and hence for tissue growth. Explain why cancerous tumours will show up clearly on a PET scan if a patient has carbon-11-methionine flowing in their bloodstream. **2**

(iii) A cyclotron is an expensive machine that can produce the radio-isotopes needed for PET scans. Explain why PET scanners must be located close to a cyclotron. **1**

(d) Evaluate the contribution that imaging techniques have made to medicine. Look at four different imaging techniques in you answer. **12**

Question 30 – Astrophysics (25 marks) **Marks**

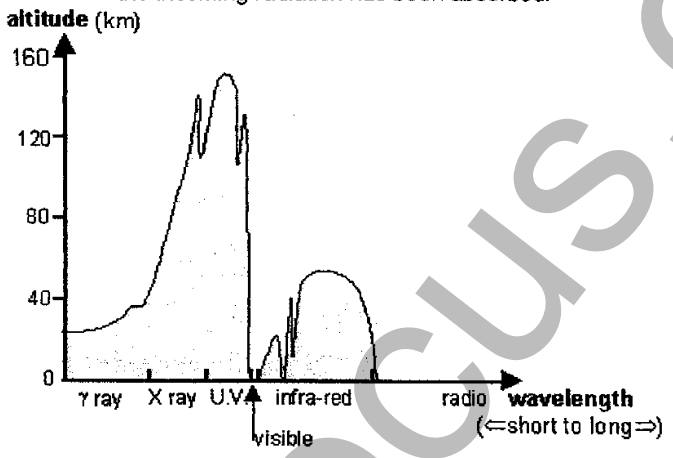
(a) Briefly outline the problems associated with ground based astronomy in terms of

(i) resolution

and (ii) selective absorption of radiation (see graph below) **3**

then (iii) explain why some types of observations are made from balloons or from space.

The graph below shows the altitude at which half the incoming radiation has been absorbed.



(b) Below are data on two stars, Vega and Achenar.

Star	Distance (pc)	Apparent Magnitude
Vega	7.7	0.03
Achenar	21.2	0.46

(i) which of the two stars is brighter? **1**

(ii) calculate the absolute magnitudes of these two stars **3**

(iii) which of the two stars is more luminous? **1**

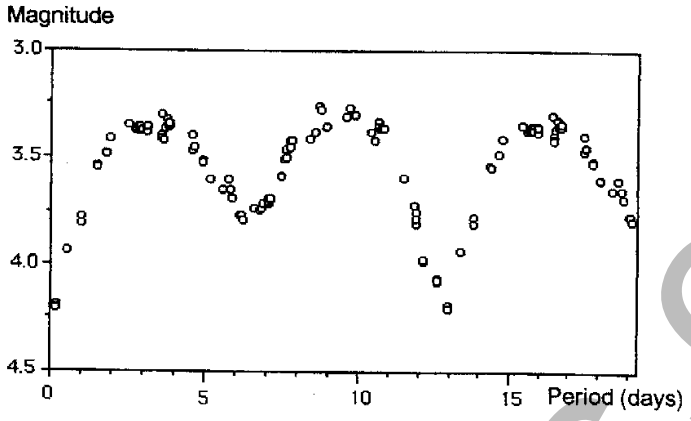
(iv) explain how a star can be less bright but more luminous. **2**

Question 30 continues on the next page

Question 30 (astrophysics), continued

Marks

(c) This is the photometric light curve for β Lyrae:-



The pattern repeats with a period of 12.9 days.

(i) What sort of astronomical "object(s)" causes the effect shown here **1**

(ii) Explain how the curves arise, and why one "dip" is deeper than the other. **2**

(d) Assess the impact that spectroscopy has had on astronomy. Look at four different types of evidence obtained from spectroscopy in your answer. **12**

Question 31 -- Quantum to Quarks (25 marks) **Marks**

(a) (i) explain the stability of electron orbits in the Bohr model of the atom using de Broglie's hypothesis **1**

(ii) An electron is moving so that its wavelength is 9.1×10^{-10}m. What is its speed? **2**

(iii) The spacing of atoms in a crystal of Nickel is about 9×10^{-10}m. Davisson and Germer used this fact in a significant way. What was it? **1**

(b) A photon of light of wavelength 4.862×10^{-7} m is emitted when the electron in a Hydrogen atom drops from a certain higher energy level into the 2nd energy level. What was the higher energy level involved? **3**

(c) The electrostatic force of repulsion between two protons in the nucleus of an atom, separated by 4×10^{-15} m is about 14 N, while the gravitational attraction between the same two protons is about 1×10^{-35} N. Account for the need for the strong nuclear force. **1**

(d) One way in which a ^{235}U nucleus can undergo fission is by this reaction:-

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{148}_{57}La + ^{85}_{35}Br + 3\,^{1}_{0}n$$

(i) What is the significance of the fact that one neutron fired in can cause three neutrons to be released? Explain what can happen. **2**

The following are some masses (in units of atomic mass, u)

$$^{235}_{92}U = 235.124\,u$$
$$^{148}_{57}La = 147.961\,u$$
$$^{85}_{35}Br = 84.938\,u$$
$$^{1}_{0}n = 1.0087\,u$$

(ii) Calculate the energy released, in MeV, from the fission of an atom of ^{235}U undergoing the reaction above. Set out your work clearly. **3**

(e) Evaluate how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking. Look at **four** advances taken from the content of this option. **12**

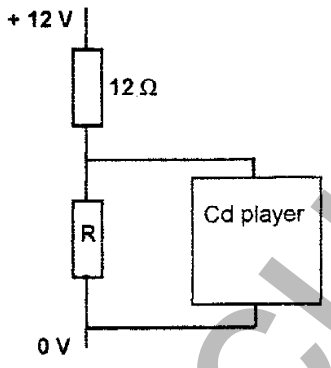
Question 32 -- Age of Silicon (25 marks) **Marks**

(a) (i) What is an input transducer in an electronic circuit? **1**

(ii) What is a negative temperature coefficient thermistor? **1**

(b) Two students have a CD player that runs on a 4.5V supply, but they want to run it in a car, off the 12V car battery. They measure the current when the CD is playing, and find that it is 170mA (at 4.5V).

They decide that they could use a potential divider to produce 4.5 V from the 12V supply (although this is not a wise way to do it). They find they already have a 12 ohm resistor, and so decide to use that in their potential divider like this:-



(i) What value should they choose for R, the lower resistor in the potential divider? **3**

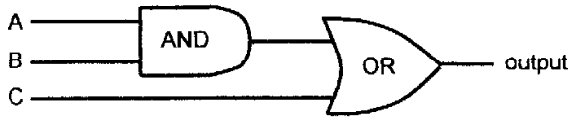
(ii) When the CD player gets to the end of the disk, it stops making sound and no longer has to turn the disk, but its microprocessor is still working. What will happens to the p.d. across it when connected to this potential divider? **1**

(iii) Explain why potential dividers are not a good "power supply" if the needed current varies. **1**

Question 32 continues on the next page:-

Question 32, continued

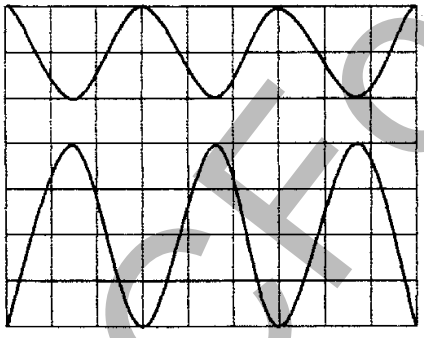
(c) The diagram below shows the output of an AND gate connected to one of the inputs of an OR gate.



Complete the truth table for this combination. **2**

A	B	C	output
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(d) The diagram below shows the input and output traces of a simple amplifier displayed on a cathode ray oscilloscope (CRO). The grid lines on the display are at 1 cm spacings. The oscilloscope settings for the traces are also shown.



Top Trace = amplifier input

y = 0.5 V/cm

Bottom trace = amplifier output

y = 10 V/cm

(i) Is this an inverting or a non-inverting amplifier? **1**

(ii) What is the gain of this amplifier? **3**

(e) Assess the impact of semiconductors on technology. In your answer look at four distinctly different semiconductor devices and their uses in technology. **12**

PHYSICS FORMULA SHEET 1

$$c = f\lambda$$

$$\text{Intensity} \propto \frac{1}{d^2}$$

$$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$$

$$E = \frac{F}{q}$$

$$R = \frac{V}{I}$$

$$P = VI$$

$$\text{Energy} = VIt$$

$$v_{av} = \frac{\Delta r}{\Delta t}$$

$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{v-u}{t}$$

$$\Sigma F = ma$$

$$E_k = \tfrac{1}{2}mv^2$$

$$p = mv$$

$$\Delta p = Ft$$

$$F = \frac{Gm_1m_2}{r^2}$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$$

$$d = \frac{1}{p}$$

$$F = BIl\sin\theta$$

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

PHYSICS FORMULA SHEET 2

$$E_p = \frac{Gm_1m_2}{r}$$

$$v = u + at$$

$$v_x^2 = u_x^2$$

$$v_y^2 = u_y^2 + 2a_y\Delta y$$

$$\Delta x = u_x t$$

$$\Delta y = u_y t + \tfrac{1}{2}a_y t^2$$

$$\frac{s}{t} = \frac{u+v}{2}$$

$$l_v = l_0\sqrt{1-\frac{v^2}{c^2}}$$

$$t_v = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$F = qvB\sin\theta$$

$$E = \frac{V}{d}$$

$$E = hf$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{[Z_2 - Z_1]^2}{[Z_2 + Z_1]^2}$$

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\lambda = \frac{h}{mv}$$

$$\text{Amplifier gain} = \frac{V_{out}}{V_{in}}$$

$$A_0 = \frac{V_0}{V_+ - V_-}$$

PHYSICS DATA SHEET

Numerical values of several constants

Charge on the electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light (in vacuo), c	3.00×10^{8} m s^{-1}
Magnetic force constant, $\left(k = \frac{\mu_o}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck's constant, h	6.626×10^{-34} J s
Rydberg's constant, R_H	1.097×10^{7} m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, r	1.00×10^{3} kg m^{-3}
Specific heat capacity of water	4.18×10^{3} J kg^{-1} K^{-1}