NAME: .....

Number .....

Physics Class (Teacher) .....

SYDNEY TECHNICAL HIGH SCHOOL

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

PHYSICS

August 2002

Section I Total Marks - 75

This section has two parts , Part A and Part B.

Part A- Multiple Choice -Total Marks - 15

Attempt all questions

Allow about 30 minutes for this part.

Part B- Extended Responses- Total Marks - 60

Attempt all questions.

Allow about 1 hour 45 minutes for this part.

Section II Total Marks- 25

Attempt all questions in the OPTION you have studied.

Allow about 45 minutes for this section.

GENERAL INSTRUCTIONS

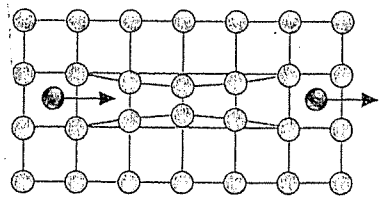
- Reading Time - 5 minutes
- Working Time - 3 hours
- Board approved calculators only may be used.
- Write in blue or black pen.
- Draw diagrams using pencil and ruler.
- A data sheet, periodic table and formulae sheet are provided.
- Show all calculations
- Record your student number at the top of each page.

Section IA (15)	Bundle A (21)	Bundle B (21)	Bundle C (21)	Bundle D (22)	Total (100)

SECTION I - PART A Multiple Choice. (15 marks)

Use the supplied Multiple Choice Answer Sheet to record your answers.

1. The following diagram shows electrons in the lattice of a superconductor.



Electrons in a superconductor:

A. join with holes to move freely past the ions that make up a crystal lattice.
B. pair up to smooth out the crystal lattice structure so they can move freely
C. are forced to form pairs by the lattice once the temperature is low enough
D. move with lattice ions, avoiding their vibrations.

2. During Hertz's experimentation with waves he observed that:
A. shining a red light on his detector made sparks jump more easily than radio waves
B. the waves produced had a length of about 20 metres
C. sparks in his detector jumped larger distances when irradiated with light from the oil lamp in his lab.
D. the waves could be refracted by a large prism (of paraffin wax)

3. A copper nail and an iron nail are placed in a beaker of dilute sulfuric acid. A voltmeter is connected across the nails. Which of the following correctly describes what this experiment indicates?

A. In this experiment chemical energy is being converted to electrical energy which is driving the DC voltmeter.

B. In this experiment the iron is at a higher potential than the copper and so the conventional current flows from the iron nail to the copper nail via the external conductor

C. This experiments models the early voltaic cells that Volta developed to generate an AC potential difference

D. The voltmeter will register a positive current which decreases to zero as the copper is consumed by the acid.

4. Heating samples of germanium and silicon will:
A. increase the resistance of both materials
B. decrease the resistance of both materials
C. increase the resistance of the silicon most
D. increase the resistance of the germanium most

5. An electric motor is often placed in series with an adjustable resistor. Why is this resistor connected in this manner?

A. to increase the operating current and reduce the starting current
B. to reduce the operating current and protect the windings in the coil
C. to reduce the starting current and protect the winding in the coil
D. to increase the starting current and improve the motor's efficiency

6. A space shuttle has an upward acceleration of 19.6 ms^{-2} during launch from Cape Canaveral. If a 70kg mass was suspended inside the craft by a spring balance, the reading on the balance during launch would be –

A. 700 N
B. 1672 N
C. 2100 N
D. 2058 N

7. A geostationary satellite

A. orbits about 42000 km from Earth's centre
B. has a period matching the period of Earth's rotation
C. orbits in the Earth's equatorial plane
D. all of the above

8. Eddy currents are an application of

A. Bragg's Law
B. Lenz's Law
C. Kepler's Third Law
D. Ampere's Law

9. In comparing samples of copper and silicon which are the same size,

A. Copper has far more free electrons than silicon
B. Silicon has the lower resistance
C. Electron drift velocity is lower in copper than in silicon
D. Silicon conducts alternating current better than copper

10. For a spacecraft of mass 75000 kg orbiting 7000 km from Earth's centre, the size of the gravitational force (in newtons) acting on it is –

A. 6.125×10^{-11}
B. 42.87×10^{-11}
C. 612500
D. 735000

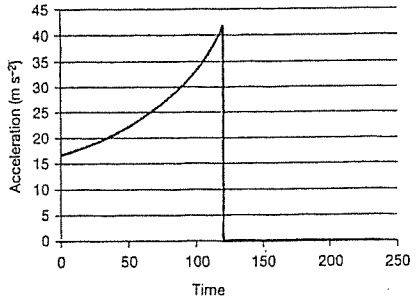
11. Some designs of Maglev trains rely on superconductors. The main limitation in this design is:

A. propelling the train forwards
B. maintaining the temperature of the superconductor
C. the need for large radius curves on the tracks
D. the chemical instability of materials based on oxides of copper.

12. A typical car ignition coil has an input potential difference of 12V DC (interrupted) and an output of 30 000 V. The ratio of (primary turns: secondary turns) will be:

A. 12 : 30 000
B. 12 x 30 000
C. 30 000 : 12
D. none of these values

13. The following graph shows the acceleration of a space vehicle during the first 250 seconds after launch. The launch vehicle consists of a space shuttle and a single stage liquid-fuel rocket with two solid-fuel booster rockets that are jettisoned after 2 minutes. The shuttle will finally go into earth orbit.

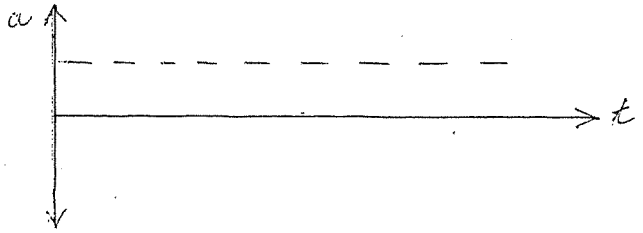


Select the correct statement about this graph.

A. The space vehicle continues to accelerate until it reaches its correct orbital velocity.
B. The space vehicle's acceleration increases rapidly during the first 120 seconds as its mass is decreasing due to the combustion of the fuel.
C. The acceleration suddenly drops to zero at 120 seconds as the shuttle has achieved its correct orbit.
D. At 120 seconds the main engine motors shut down and the vehicle maintains a constant velocity.

14. A student releases a ball from eye level in a gravity field. The ball bounces several times on the ground below. Which acceleration versus time graph best represents the ball's motion?

A.



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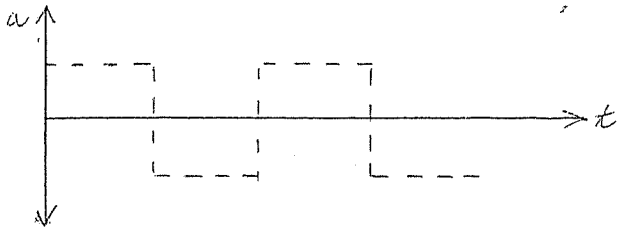

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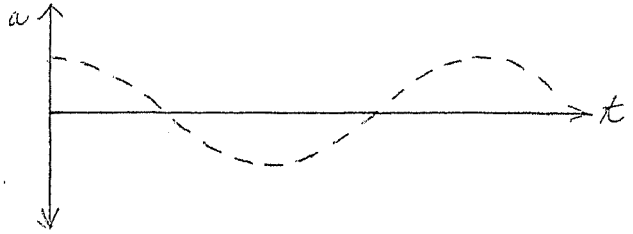
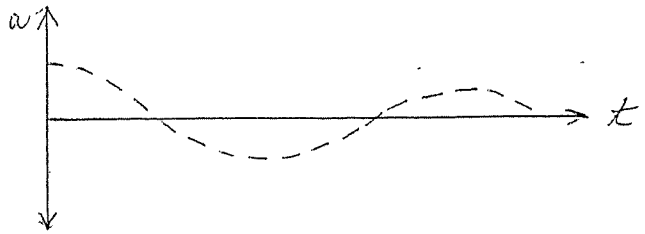
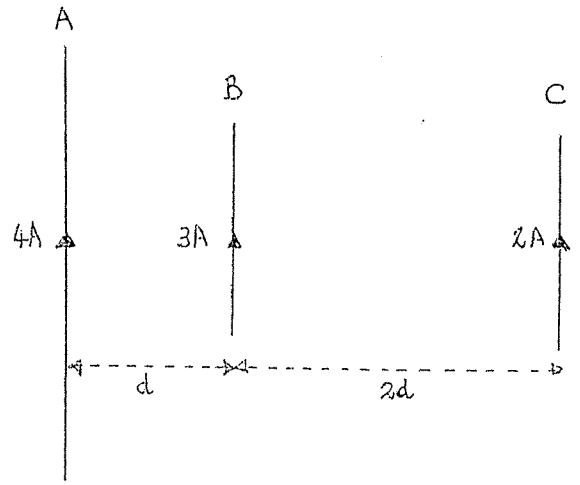


D.



15. Three parallel wires, A ,B and C lie in the same plane. Wire A has a length of 4m; B & C are both 2m long. The sizes and directions of currents are indicated on the diagram. The separation between B and C is twice that between A and B.



Since wire A exerts 8N on wire B, the size and direction of the force exerted by C on B is:

A. 2N to the left

B. 2N to the right

C. 1N to the right

D. 4N to the right.

BUNDLE (A)- (21 marks)

SECTION I - PART B Extended Response.
Record all answers in the spaces provided.

16. (2 marks) Describe the evidence that has been collected about the physiological effects on humans living near high voltage power lines.

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17. Exploration of Mars was in the headlines recently with the failure of some missions to send exploration craft to the "red planet's" surface. In comparison, missions to the Moon have been able to return men and rock samples with spectacular success.

While Mars' great distance obviously makes exploration harder, gravity also plays a part.

a) (1 mark) The escape velocity "v" of an object from the surface of an astronomical body of mass M and radius r , is given by the formula:

$$v^2 = 2GM/r$$

Show , using appropriate equations from the Formulae Sheet, how this formula is derived.

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b) (2 marks) Using the equation from (a) ,compare the velocity with which a mass (m) being returned to Earth must be sent from the surface of

(i) the Moon (ii) Mars,

, to the velocity needed to escape from Earth on the outward trip.

Data:	Diameter	Mass	Earth masses
Moon	3 475 km	7.3483×10^{22} kg	0.0123
Mars	6 794 km	6.4191×10^{23} kg	0.107
Earth	12 756 km	5.9742×10^{24} kg	1 (by definition)

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c)(2 marks) Use your answer from (b) to explain the proposal that nuclear-powered, fuel gathering/manufacturing machines should be sent to Mars ahead of any attempt to send humans.

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18. (5 marks) The microwaves (~2·4 × 10^9 Hz) used to cook food in a microwave oven are produced using a device called a magnetron. As part of the process of generating the microwaves, groups of electrons are accelerated and made to follow a uniform circular path in an electric and magnetic field.

A certain magnetron causes electrons to follow a circular path that is 1 cm in diameter with an orbital frequency of 800 MHz (i.e. a third of the output microwave frequency).

(N.B. show answers to 2 decimal places, but keep intermediate results on your calculator for best accuracy).

a) Describe the required orientation of the magnetic field relative to the electric field in the magnetron that will lead to the circular motion of the electrons.

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b) What is the electron velocity (i.e. tangential or peripheral speed) associated with this orbital frequency?

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c) The kinetic energy of an orbiting electron is equal to the work done in accelerating the electron (charge q) through a potential difference (V). The work done is given by the formula:

Work = q.V

How large an accelerating voltage is needed to give an electron this velocity?

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d) The centripetal force (F) acting on a body of mass "m" in an orbit of radius "r" is:

$F = mv^2/r$

How large must the centripetal force be for an electron to follow the circular path described above ?

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e) What magnetic field strength is needed to make electrons follow this path?

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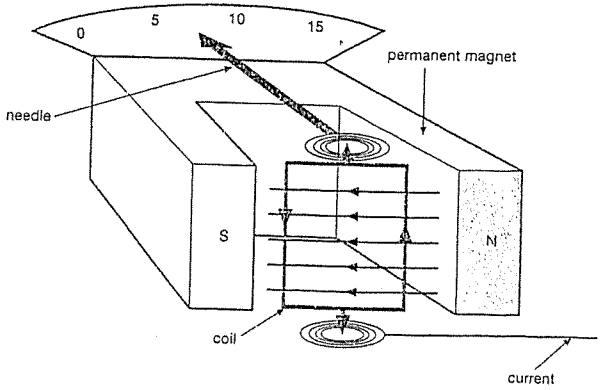
19. (2 marks) While motors and meters share some characteristics, the main difference is that motors are meant to turn continuously for as long as energy is supplied. The following diagram shows a simplified diagram of a galvanometer.



a) What purposes are served by the thin ('hair') springs attached to a galvanometer's coil?

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b) In what way might the operation of a galvanometer be altered by substituting stiffer springs (i.e. ones which bend less easily) in place of the original ones?

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20. (2 marks) Energy distribution around cities is a costly business. Discuss two major aspects of direct current generation and distribution systems that make such systems more expensive to implement, run and maintain than the alternating current systems which are used in places like Sydney.

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21. (2 marks) Explain qualitatively Hertz's experiments to prove that Hertzian waves (radiowaves) were electromagnetic waves with wavelengths much greater than visible light waves.

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22 (2 marks) Galileo and Newton envisioned a universe in which quantities such as force and velocity could be added as simple vector quantities. This results in predictions such as :

"A stationary observer will measure the velocity of a bullet as being 350m.s^{-1} South, if it is fired with a muzzle-velocity of 400 m.s^{-1} southwards from a vehicle moving at 50 m.s^{-1} to the north."

a) What measurable quantities did Newton regard as being absolute (i.e. the same for all observers)?

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b) Describe the circumstances under which this method of prediction has been found to be inaccurate.

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23. (1mark) Describe the relationship between the drift velocity of electrons and the cross-sectional area of the conducting wire.

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Total Bundle A (21)

BUNDLE (B) (21 marks)

24. (6 marks) Discuss, using named examples and appropriately labelled diagrams or graphs, the difference between conductors, insulators and semiconductors in terms of band structures, energy gaps and electrical resistance.

25. (2marks) Step-up transformers are located at all Snowy Scheme power stations. Explain why such devices are an essential part of the NSW electricity grid.

26. (3 marks) In a simple DC motor, torque may vary in size but must have a constant direction. Explain,

(a) with the aid of a diagram and using a relevant equation how the size of the torque varies during the rotation of the armature.

(b) how a DC current is produced as the coil rotates in only one direction.

27. (3 marks) A 150-m long spaceship travelling at 0.9c is seen passing from left to right across the 0.5 degree field of view of an Earth-based observer's telescope. It is observed for 20 seconds.

a) How many seconds pass on a clock inside the spacecraft during the Earth-based observer's 20 seconds.

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b) What length does the craft appear to the Earth-based observer?

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c) Make a justified comment on the distance of the spacecraft from the observer given that 0.5 degrees is the angular size of both the Sun and Moon in the sky.

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28. (a) (2 marks) An electron gun is one component of a cathode ray tube in a television set and a cathode ray oscilloscope. With the aid of a labelled diagram, describe the function of the electron gun

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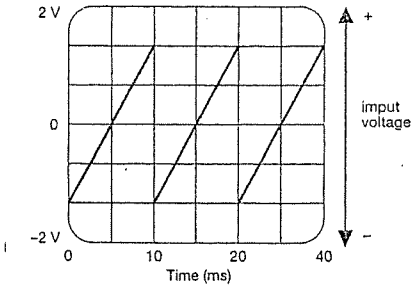
(b) (2 marks) The following diagram show the screen of a cathode ray oscilloscope which is displaying a saw-tooth voltage versus time. Explain how such a display is produced by the cathode ray oscilloscope.



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29. (3 marks) A spacecraft is orbiting 500 km above the Earth's surface. Calculate it's orbital period given that the radius of the planet is 6378 km. Show all working .

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Total Bundle B (21)

BUNDLE (C) Core Questions (18 marks) & Option Question (3 marks)

30. (1 mark) Identify how transmission lines are insulated from supporting structures.

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31. (3 marks) Students are required to experimentally determine the acceleration due to gravity near the surface of the Earth. The equipment available is:

3 different masses (3kg, 4kg, 5kg)
a beam (counterpoise) balance
a newton meter (spring balance)

(a) Outline the experimental and calculation steps that need to be performed in order to determine a value for "g". You do not have to perform the calculations.

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(b) Identify one strategy that will optimize the accuracy of the procedure and one strategy that will optimize the reliability of the procedure.

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(c) Evaluate the readings taken from both kinds of balances for the 4kg mass if the experiment was repeated in a laboratory on the surface of the Moon.

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32. (3 marks) During your coursework you have performed a first hand investigation to model the experiments of Michael Faraday. Justify how your results support the relationship between the generated potential difference and the rate of change of magnetic flux.

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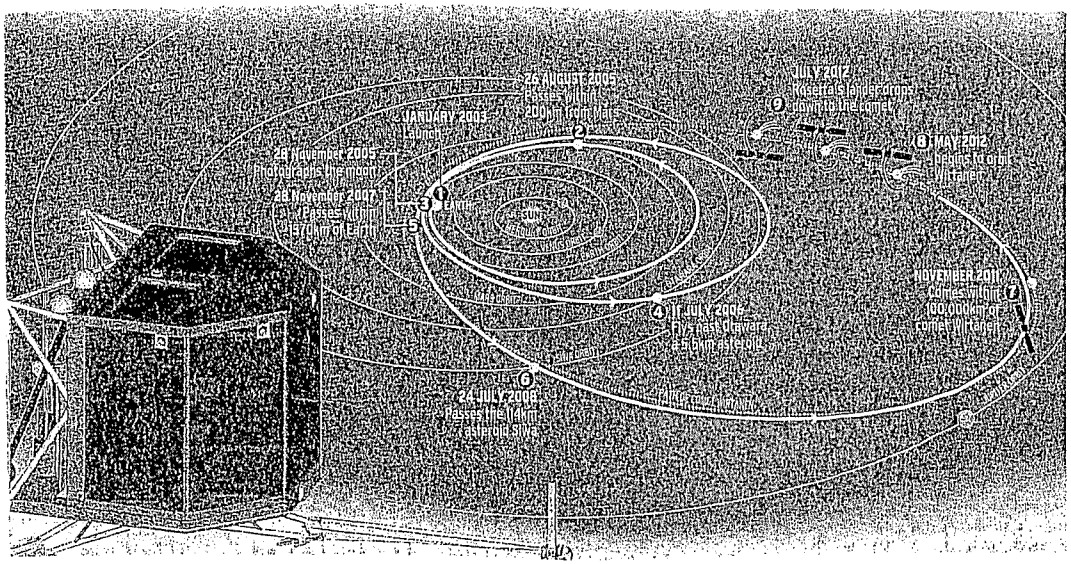
33. In January 2003 , the European Space Agency will launch the three tonne Rosetta probe to rendezvous and land on the surface of the comet Wirtanen in July 2012. The following graphic shows the key events in the mission.



Questions on next page.....

(a)(2 marks) Discuss why such a long route was selected rather than sending the probe directly towards the comet.

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(b)(2 marks) The Rosetta probe, unlike previous nuclear powered probes, will use 70 square metres of solar panels to capture solar energy. Discuss the problems of using such technology during the long flight.

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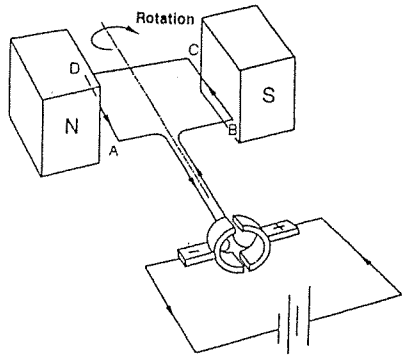
34. The diagram shows a simplified electric motor . The rectangular coil has the following dimensions:

AB = 60cm
BC = 80 cm

The coil carries 2 amps of current. The uniform magnetic field has a strength of 0.4T.



(i) (1 mark) What is the size of the maximum torque generated?

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(ii) (1 mark) Calculate the angle between the plane of the coil and the horizontal which will produce a torque of 0. 2Nm.

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(iii) (2 marks) In terms of conservation of energy, discuss the fact that an operating electric motor will also generate a potential difference.

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(iv) (1 mark) Explain how the generated potential difference will influence the maximum speed of the motor.

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35. (2 marks) Assess Einstein's contribution to the quantum theory and its relation to black body radiation.

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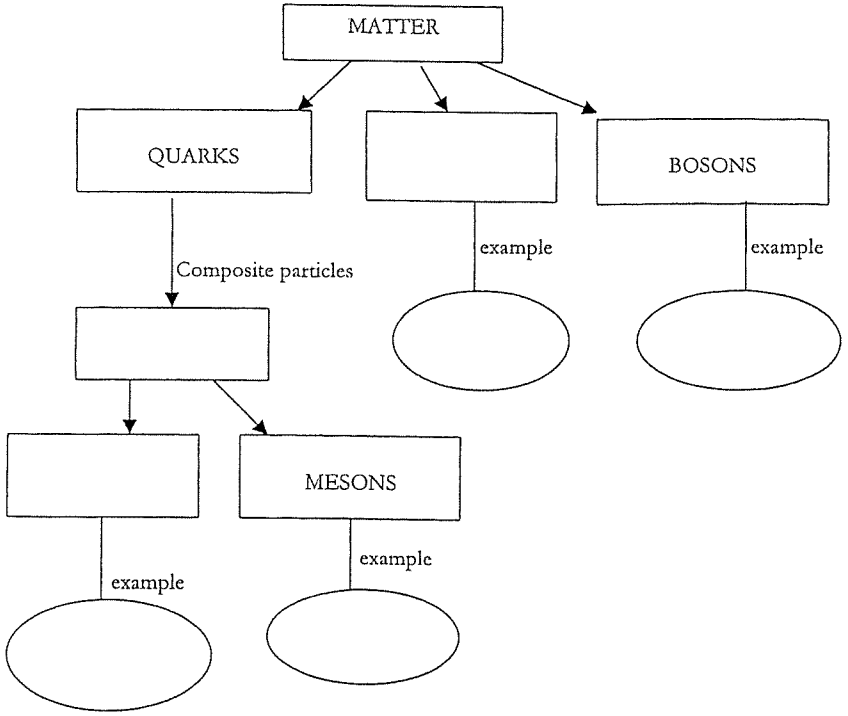
SECTION II OPTION.

FROM QUANTA TO QUARKS

36. (3 marks) Our attempts to understand matter is an ongoing process. Complete the flow chart which classifies the components of the standard model of matter into matter particles and force-carrier particles. Write the classification family in each rectangular box and one example of this family in each oval.



Total Bundle C (21)

BUNDLE D - Option Questions (22 marks)

37. (1 mark) Which of the following is the best estimate of the de Broglie wavelength of an athlete running a 100 metre sprint? Circle the correct letter.

A. 10^{-37}m

B. 10^{-31}m

C. 10^{-19}m

D. 10^{-16}m

38. (1 marks) The Rutherford model of the atom was based on alpha particle scattering experiments. Alpha particles are fired at a thin gold foil. When an alpha particle does not approach the nucleus head-on, its kinetic energy at the point of closest approach is: (circle the correct letter)

A. zero

B. a maximum

C. a minimum

D. the same as the initial kinetic energy.

39. (a) (3 marks) Use a labelled diagram to explain the operation of magnetic lenses in electron microscopes.

(b) (3 marks) Assess the impact of the development of electron microscopes on our understanding of the structure of materials.

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40. (3 marks) Consider the first three energy levels (E_1, E_2 and E_3) for an atom.

In a transition from E_3 to E_1 radiation of wavelength 600nm is emitted.
In a transition from E_2 to E_1 radiation of wavelength 800nm is emitted.

(a) Calculate the wavelength of the radiation that would be emitted in a transition from E_3 to E_2

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(b) In which part of the electromagnetic spectrum would this spectral line be observed?

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41. (3 marks) Four spectral lines are observable in the visible region of the hydrogen emission spectrum Calculate the frequency of the highest energy spectral line in the visible region of the Balmer series. Show all working.

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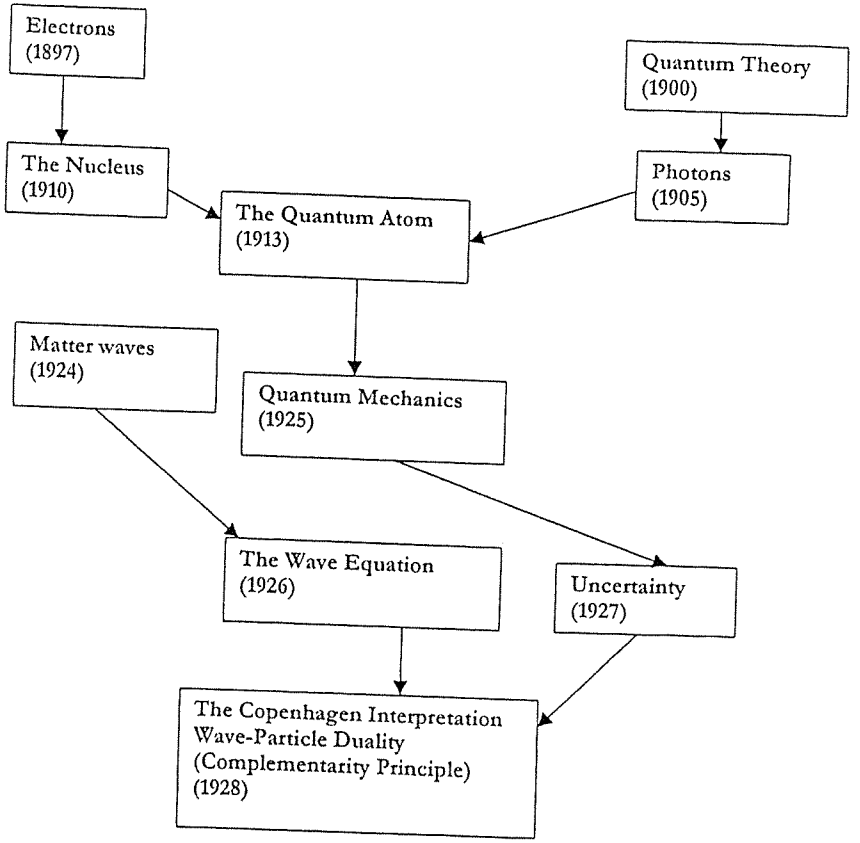
42. (8 marks) The following flow chart shows some of the important developments in atomic physics from the late nineteenth century to the end of the 1920's.

Discuss in detail how the work of Planck, Bohr, Heisenberg and de Broglie changed our understanding of the atom.



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Total Bundle D (22)

TRIAL PHYSICS 2002
ANSWERS AND MARKING SCHEME

MULTIPLE CHOICE.
1C; 2D; 3A; 4B; 5C; 6D; 7D; 8B; 9A OR 9C ; 10C; 11B; 12A; 13B; 14A ; 15B

BUNDLE A

16. In describing the evidence the student must indicate the tentative nature of the available information and that no firm conclusions can be currently drawn...eg contradictory evidence between surveys and lab testing. (2marks)

17. a. (1 mark) K.E. = P.E. so $1/2mv^2 = GMm/r$. Now rearrange to give v^2 :
thus, $v^2 = 2GM/r$

b. (2 marks) Substitution into the previous equation gives the escape velocities (mark loss if Earth not mentioned)
Earth (11.2 km/s) ; Mars (5.02 km/s) ; Moon (2.375 km/s) ; Statement of the order of sizes is required.

(c) (2 marks) Return from Mars would require a lot of fuel for take off compared with the Moon.
It is very expensive to send fuel from the Earth so "making" fuel there is an attractive option.
Nuclear power is a better proposal than solar or wind energy as these methods of obtaining energy are not likely to be viable due to the uncertainties of Martian weather.

18. (a) (1 mark) B vector is perpendicular to E vector.
(b)(1 mark) $v = \pi df = \pi(0.01)(8 \times 10^8) = 2.5 \times 10^7 m/s$
(c) (1 mark) $1/2mv^2 = qV$
$V = mv^2/2q = 1.8 \times 10^3 V$(working to be shown)
(d) (1 mark) $F = mv^2/r = 1.15 \times 10^{-13} N$(working to be shown)
(e) (1 mark) $B = F/qv = 0.0286 T$ (working to be shown)

19 a. (1 mark) conduct I(max half-mark); provide restoring force/opposing torque due to I
b. (1 mark) increase of torque/unit deflection...therefore, reduces sensitivity to current.

20. (2 marks) Choose any two (without repetition of point or missing cause with effect)
eg. generators' commutators are expensive to make and maintain compared to slip rings ;
converting to high V (low I transmission) is harder to do economically(usually more wasteful too)
thus generation at a voltage just above voltage for users which makes for more I^2R loss in transmission lines
switch gear must stop the I flowing (AC stops twice per cycle) by opening quickly or being in oil etc

21. (2 marks) Possible answers include:
* Setting up standing waves with "mirror" and measuring λ or $\lambda/2$ by interference
* Induction in test loop from both E vector and B vector (at right angles) components of wave on wire (standing wave)
* Lloyd's mirror method. . .measure the maxima and minima in the interference pattern.

Marks deducted for: refraction(refractive index not measurable without v) ; $v = f\lambda$; reflection alone without mentioning interference.

22a.(1 mark) mass, time, length (space) (deduct half mark if only two are mentioned)
b(1 mark) It is inaccurate when : v approaches c ; a does not equal zero for observer (ie observer in accelerated frame) ; g does not equal zero in region ; (choose one of these answers)

23. (1 mark) Drift velocity is inversely proportional to cross sectional area (at constant I)

BUNDLE B

24. (6 marks) The following points must be made to secure full marks:
Conductors: diagram correctly labelled; show overlapping C and V bands ; discuss the reasons for low resistance ; name an example
Insulators: diagram correctly labelled ; show large gap between C and V ; discuss the reasons for high resistance ; name an example
Semiconductor: diagram correctly labelled ; show small gap between C and V bands ; discuss reasons for medium resistance ; include an named example

25. (0.5 marks) Discuss the distance factor ; (0.5 marks) boosting V reduces I ; (1 mark) Power loss due to I^2R heating is reduced when I is low.

26. (Note part (b) is eliminated due to typographical error.. Part (a) is marked out of 3) material in (b) that was useful in part (a) was still counted towards the mark for part (b)
(1 mark) $\tau = BIAnCos\theta$
(1mark) coil parallel to B gives maximum torque, coil at right angles to B gives zero torque
(1 mark) but torque is kept positive by using split ring commutator.

27. (a) (1 mark) Use time dilation formula to calculate the time on the spacecraft. Answer = 8.7seconds (no half marks)
(b) (1 mark) Use length contraction formula; Answer = 65.4 m (no half marks)
(c) (1 mark) Since it is moving at 0.9c, in 20 seconds it moves a distance s where,
$s = vt = 0.9c \times 20 = 5.4 \times 10^9$ m ; s is the length of an arc on a circle(radius r) with the Earth at the centre. Such an arc is larger than the apparent diameter of the Sun and so the craft must be beyond the Sun.
(Or Mathematically.. $s = r\theta$ ($\theta = 0.5° = 8.73 \times 10^{-3}$radians) ; Thus $r = s/\theta = 5.4 \times 10^9/8.73 \times 10^{-3} = 6.18 \times 10^{11}$ m (compare with the Sun's distance from the Earth = 150 million km = 1.5×10^{11}m) ; Thus the craft must be beyond the Sun to subtend an angle of 0.5° for 20 seconds.)
28. (a) (2 marks) Using the labelled diagram, marks are awarded as follows:
1/2 marks- production of electrons by thermionic emission from filament(cathode).
1/2 marks - negative grid (between anode and cathode) controls intensity of electrons (spot brightness)
1/2 marks - electron guns two open cylinder anodes- controls focus and acceleration of electrons
1/2 marks- labelled diagram showing above
(b) (1 mark) - saw-tooth voltage input to Y deflection plate and time base to X deflection plate
(1 mark) - the time base runs 10ms then cuts off and signal input restarts to create saw-tooth pattern
(half-mark if answer states that electron hits phosphors on screen and a glowing trace is produced).

29 (3 marks) 1 mark for $T^2 = 4\pi^2r^3/GM$ rearrangement
1 marks for $r = (6378 + 500) \times 10^3$ m
1 mark calculating the orbital period (T = 5665.4s = 1.57 hr)
(minus 1 mark for not cubing r)

BUNDLE C

30. (1 mark) transmission lines are connected to porcelain insulators which are connected ti supporting structures (Note rubber coated wires are distribution lines , not transmission lines)

31 (a) Mass determined on beam balance and weight force on spring balance (newton meter) - 1/2 marks
W =,mg or g = W/m or F =ma (1/2 marks)
(b) Accuracy - improved equipment or technique (1/2 mark)
Reliability- repetitions (1/2 marks) (Reliability and accuracy must be identified.

(c) beam balance - mass reading unchanged (1/2 marks)
newton meter - weight reading greatly reduced (1/2 marks)

32. Marks awarded here were affected by the clarity of logic and presentation of thought.
Relationship discovered by Faraday (emf is proportional to rate of change of flux (ϕ) (1 mark)
Student investigation mentioned (1 mark)
Justification from own results (1 mark)

33. (a) (2 marks) Slingshot effect saves fuel, mass, rocket power etc. Angular momentum transferred from planets to probe (best answers)
Close-up investigations of various satellites (Moon , Mars , asteroids)
Note: "Directly towards comet" means an elliptical path without gravity assist loops, not a path across the solar system , perpendicularly intersecting the comet).
(b) (2 marks) Intensity of incoming energy will be very low at the distant parts of the flight since I is proportional to the inverse square of the distance. (best answer)
Large panel area likely to be damaged by space debris
Fragility of panels
Susceptibility to solar storms.

34. (i) $\tau = nBIA = 1 \times 0.4 \times 2 \times 0.6 \times 0.8 = 0.384$ Nm (1 mark)
(ii) $\tau = 0.2$ Nm. $\cos\theta \times 0.384 = 0.2$
Thus $\theta = 58°39'$ (1 mark)
(iii)(2 marks) Operating electric motor includes wires moving through an electric field. This will generate an emf (back emf). In terms of the conservation of energy, the back emf cannot assist the motion of the motor. If it did the motor windings would accelerate and kinetic energy would be created from nothing.
NB Back emf produces no induced electric current, nor any magnetic field
(iv) Size of the back emf rises with speed of the motor (half mark) until it balances the applied emf, preventing further acceleration (half mark)
(Back emf reduces the maximum speed of the motor scores half a mark only.)

35. (2 marks)
* Einstein and quantum theory – Einstein used quantum theory to explain the photoelectric effect;_ a photon gives up all or none of its energy to an electron at the surface of a metal.
$E_K(max) = hf - \phi = qV_{stop}$
$= hf - hf_o$
The work function (ϕ) is the work done in overcoming the attractive forces at the surface of the metal.

* Quantum theory and black body radiation- Quantum theory and not classical physics explained the shape of the black body radiation curves, particularly at the high frequency (UV) end.

36. (3 marks – 2 correct = 0.5 marks; 3 correct = 1 mark etc... all correct = 3 marks)
second line = LEPTONS
third line = HADRONS ; (Electron or neutrino or muon or tau, etc) ;
(Photon or gluon or weakon , W, Z or gauge particle)
fourth line = BARYONS
fifth line = (Protons or neutrons) ; (pions)

BUNDLE D

37. A (wavelength must be less than Planck's constant for an athlete)

38. C. As the alpha approach is non-head on, then the kinetic energy cannot be zero, but a minimum as repulsion slows the alpha down.

39(a) . 1 mark - for a labelled diagram which shows electrons refracting due to the asymmetric magnetic field. the diagram should show the field is strongest near the walls. Too many poor, unlabelled diagrams which did not show the asymmetry of the magnetic fields.
2- marks for the explanation ; points to include- (a) lens consists of a coil of wire surrounded by a soft iron shroud (b) magnetic field is concentrated at a small gap in the soft iron (c) magnetic field lines are curved; electrons have a component velocity that is perpendicular to the field lines- this produces a force perpendicular to the velocity vector (d) the centripetal force on the electron focuses the beam (e) electrons further from the central axis experience a stronger focussing force.

39(b) The verb ASSESS requires a value judgement of the worth of this technology... this can only be done with specific examples (minimum 2 examples would be expected).Many students did not mention any specific examples. One mark (maximum) was awarded if only higher resolution and magnification (due to lower wavelength) were mentioned.
Examples could include:
Cell biology – the fine detail of cellular structure is revealed and then organelle function can be related to these structures.
Crystals and materials – topology and morphology of crystals can now be seen in finer detail ..important in semiconductor research and detecting flaws in welds etc

40. (a) 2 marks- ΔE_1 for the transition from 3 to 1 is calculated : $\Delta E_1 = hc/\lambda = 3.313 \times 10^{-19}$J
ΔE_2 for the 2 to 1 transition is: $\Delta E_2 = hc/\lambda = 2.485 \times 10^{-19}$J
Thus for the transition from E3 to E2, the energy change is the difference between the above values;
$\Delta E_3 = 0.828 \times 10^{-19}$J
$\lambda = hc/\Delta E_3 = 2.407 \times 10^{-6}$m = 2407nm

(b) infrared (1 mark) (or answer consistent with the wavelength from part (a)

41. 1 mark for $n_i = 6$ and $n_f = 2$
1 mark for wavelength calculation using Rydberg equation (method shown).
answer = $\lambda = 4.102 \times 10^{-7}$m
1 mark for frequency calculation: $f = c/\lambda = 7.31 \times 10^{14}$Hz

42. 1 mark – Planck – Quantum Theory (1900). marks awarded for Planck's proposal about quantisation of energy and how this proposal was used to explain the black body radiation curves.
3 marks- discussion of Bohrs' three postulates of the Quantum atom (1913) as being a necessary modification of Rutherford's model ; Bohr;s model also had its own limitations
1 mark – De Broglie Matter waves (1924)- moving particles have a wave nature; wavelength of elctrons similar to atomic dimensions ; $\lambda = h/p$; verified by Davisson and Germer experiment
2 marks- Heisenberg (Quantum mechanics (1925)/ Uncertainty principle (1927)) Discuss Heisenberg's development of quantum mechanics as a form of matrix algebra that explained the electron structure of the atom; using photons to detect electrons disturbs the electron and scatters it; There is an uncertainty in our knowledge of the electrons position and momentum as expressed by Heisenberg's equation.
1 mark – Complementarity principle (Bohr/Heisenberg)(1928) De Broglie's matter waves and wave mechanics are used to explain electrons in terms of both particles and waves. They can be thought of as forming standing wave patterns in the allowed Bohr orbits.
Too many students wasted space with introductory and final paragraphs that said nothing concrete (ie, waffle); Some space was wasted with discussion about scientists other than those mentioned in the question... these should only be mentioned briefly if relevant.