TERTIARY ENTRANCE EXAMINATION, 1991

QUESTION/ANSWER BOOKLET FOR SECTION A

PHYSICS

Please place one of your student identification labels in this box

SEA STUDENT NUMBER – In figures

In words _____

_____

TIME ALLOWED FOR THIS PAPER (FOR SECTIONS A & B)

Reading time before commencing: Ten minutes
Working time for paper: Three hours

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER (FOR SECTIONS A & B)

TO BE PROVIDED BY THE SUPERVISOR

This Question/Answer Booklet comprising 21 pages for Section A - 30 questions.
Question/Answer Booklet comprising 19 pages for Section B - 8 questions (inside front cover of this Question/Answer Booklet)
Paper Binder

TO BE PROVIDED BY THE CANDIDATE

Standard Items: Pens, pencils, eraser or correction fluid, ruler

Special Items: Mathematical & Statistical Tables and Chemical Data Booklet, a calculator satisfying the conditions set by the Secondary Education Authority, compass, protractor and set square.

NOTE: Personal copies of Tables/Booklet should not contain any handwritten or typewritten notes, symbols, signs, formulae or any other marks (including underlining and highlighting), except the name and address of the candidate, and may be inspected during the examination.

IMPORTANT NOTE TO CANDIDATES

No other items may be taken into the examination room.

It is your responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. Please check carefully, and if you have any unauthorised material with you, hand it to the supervisor BEFORE reading any further.

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SEE PAGE 3

INSTRUCTIONS TO CANDIDATES

This examination consists of **TWO (2)** Question/Answer Booklets.

In the Question/Answer Booklet for Section A, answer **ALL** thirty questions, and write your answers in the spaces provided beneath each question. This section is worth 48% of the marks for the examination. Each of these questions is of equal value.

In Section B, answer **ALL** eight questions, and write your answers in the Question/Answer Booklet for Section B. This section is worth 52% of the marks for the examination.

Note that (where appropriate) answers should be given numerically and that they should be evaluated and not left in fractional or radical form. Give all answers to three significant figures unless otherwise instructed.

A calculator satisfying the conditions set by the Secondary Education Authority and approved mathematical tables may be used to evaluate numerical answers.

Despite an incorrect final result, credit may be obtained for method and working, provided these are clearly and legibly set out.

At the commencement of this examination, attach your STUDENT IDENTIFICATION labels to the front cover of each Question/Answer Booklet. Write your SEA Student Number in the spaces provided in each of the Question/Answer Booklets.

At the end of the examination both Question/Answer Booklets must be attached with the paper binder provided.

REFER TO PAGE 21 FOR PHYSICAL CONSTANTS

NOTE: Page 21 is perforated and may be removed for easier use during the examination.

SEE PAGE 4

SECTION A

MARKS ALLOTTED : 48

Attempt all thirty 30 questions in this section. All questions are worth equal marks. **Answers are to be written in the spaces below or next to the question.**

Evaluate answers numerically where possible. Credit will be given for working, if shown. Numerical constants are listed on page 21.

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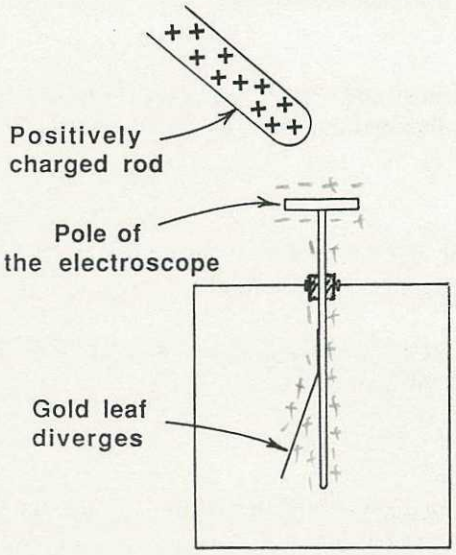
1. A positively charged insulating rod is brought near to, but not touching, the pole of a gold leaf electroscope. The leaf is observed to diverge as shown in the figure.



   (a) Indicate on the diagram the resultant charge distribution on the electroscope.

   (b) Hence explain why the leaf diverges.

SEE PAGE 5

2. It takes 2·00 minutes to cook a slice of toast using a 2·00 kilowatt toaster which is running off the 250 V mains power supply.

(a) What current is drawn while the toast is being cooked?

(b) How many electrons pass through your toaster in this time?

3. Measurements have shown that only 1·00 percent of the electrical energy consumed by a light bulb is emitted in the form of visible light.

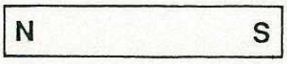
(a) Calculate the rate at which visible light energy is emitted from a light globe running at 110 V and a current of 0·370 A.

(b) What happens to the rest of the energy?

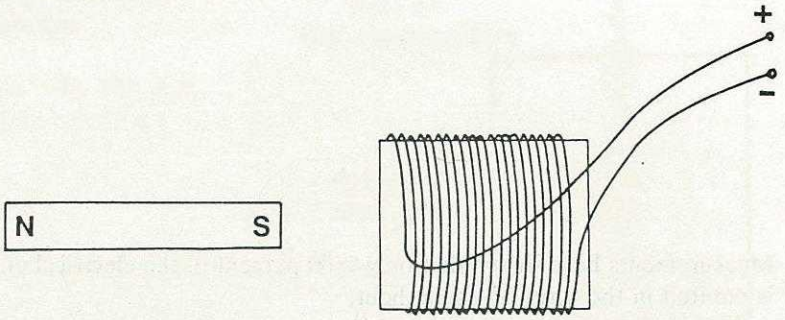
SEE PAGE 6

4. Sketch the magnetic field lines around each of the following. Be sure to indicate field direction.

(a) A bar magnet in outer space.



(b) A bar magnet next to a current-carrying coil.



5. Synthetic shirts made from materials such as polyester or nylon sometimes stick to your body and make a crackling noise as they are taken off.

(a) Explain why this type of shirt sticks to you.

(b) Explain what causes the crackling noise.

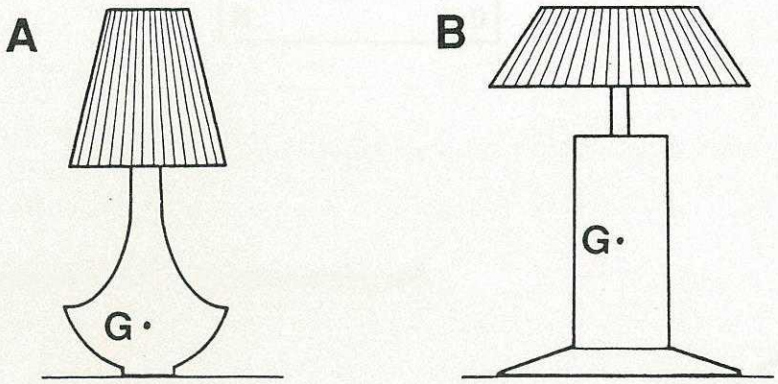
SEE PAGE 7

6. A tennis ball of mass 55·0 g is dropped vertically and strikes the ground with a speed of 5·50 m s^{-1}. The ball rebounds along the same path at 4·50 m s^{-1}. What is the magnitude and direction of the change in momentum of the ball?

7. Two empty railway wagons, which are coupled together and travelling along a level section of track at 2·50 m s^{-1}, collide with a third stationary wagon which is identical except that it has a load on it. Each wagon has a mass of 1850 kg. The three wagons couple together and move off at a velocity of 1·00 m s^{-1}. What is the mass of the load on the third wagon?

SEE PAGE 8

8. The diagrams below show two designs for table lamps. In each case the position of the centre of mass is marked G.

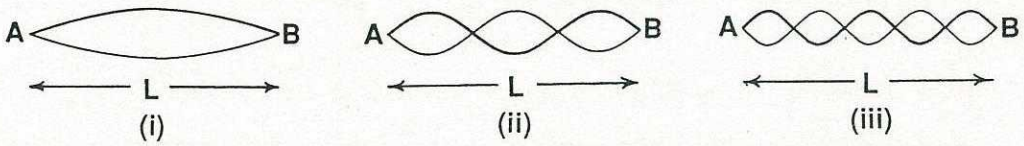


(a) Which of these two lamps (A or B) is the more stable? _____

(b) Sketch construction lines and place labels on the above diagrams and write notes to explain your choice.

SEE PAGE 9

9. A stretched string may vibrate in a number of ways. Three possible ways for a particular string to vibrate are shown in the diagram below. The tension is the same in each case.



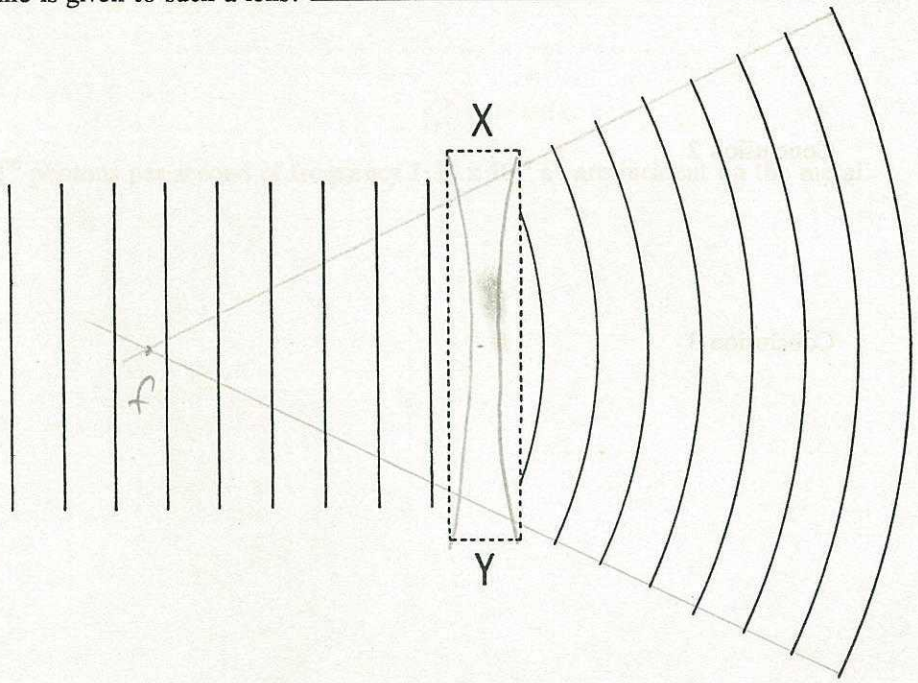
If the frequency in (ii) is 510 Hz what are the frequencies in (i) and (iii)?

10. A parallel beam of light is incident on a lens (XY) placed as indicated in the diagram. The incident parallel wavefronts are refracted and emerge as shown.

(a) On the diagram below sketch

(i) the shape (cross-section) of the lens and
(ii) the approximate position of the focal point of the lens.

(b) What name is given to such a lens? double concave



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11. (a) What maximum force could be exerted by the Earth's magnetic field of 0·450 μT on a wire of length $1{\cdot}00 \times 10^2$ mm which is carrying a current of 0·500 A?

(b) Is the orientation of the wire in the field important? If so, explain how the maximum force can be obtained.

12. It is known that an electron moves through a region of space with uniform velocity. There are three possible conclusions which could be drawn about the electric field and the magnetic field in this region. What are these conclusions?

Note: Simple sketches and/or notes can be used to answer this question.

Conclusion 1

Conclusion 2

Conclusion 3

SEE PAGE 11

13. The activity of a sample of a highly radioactive material is observed to decrease by a factor of 8 in 27·0 hours. What is the half-life of the material?

14. The work function of a particular metal is 1·20 eV. Calculate the maximum rate at which photoelectrons could be ejected from the surface of the metal if:

(a) $1{\cdot}00 \times 10^{8}$ photons per second of frequency $7{\cdot}20 \times 10^{14}$ s^{-1} are incident on the metal.

(b) $1{\cdot}00 \times 10^{10}$ photons per second of frequency $1{\cdot}30 \times 10^{14}$ s^{-1} are incident on the metal.

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15. In a nuclear reactor the isotope $^{235}_{92}U$ captures a neutron and subsequently undergoes a nuclear reaction with the release of a large amount of energy.

(a) Complete the equation for the reaction

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + \square + 200MeV$$

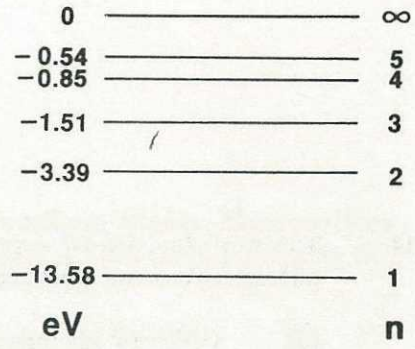
(b) Name the type of nuclear reaction represented by this equation.

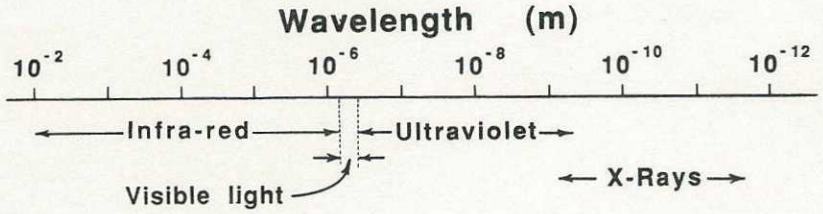
_____

(c) Name the missing particles. _____

16. The energy levels of a hydrogen atom are illustrated in the adjacent diagram.

Use the information provided on the electromagnetic spectrum shown in the diagram below and perform a calculation to determine the type of radiation associated with an electron transition between n = 5 and n = 1.





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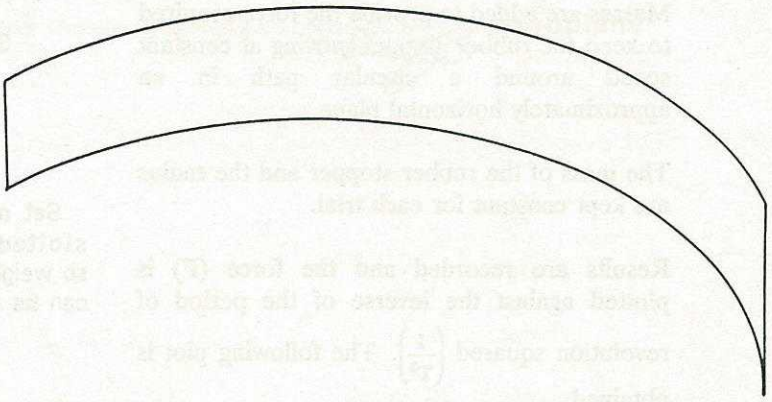
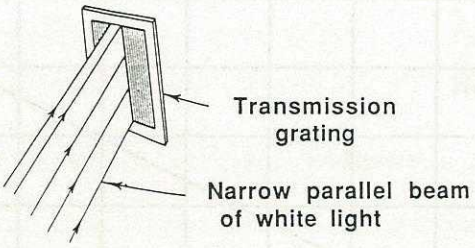
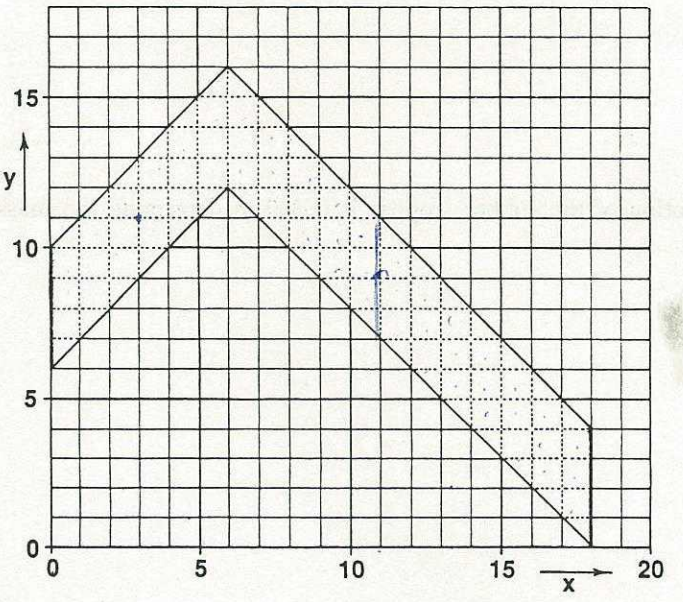
17. Visible light is incident normally on a transmission diffraction grating as shown. On the diagram indicate the positions of

(a) the first and second order spectra.
(b) the red and blue ends of each of these spectra.





18. The boomerang-shaped object shown in the diagram is made from plywood of uniform thickness. Find the grid reference of the centre of mass of this object (x,y). Marks will be awarded for construction lines if shown.



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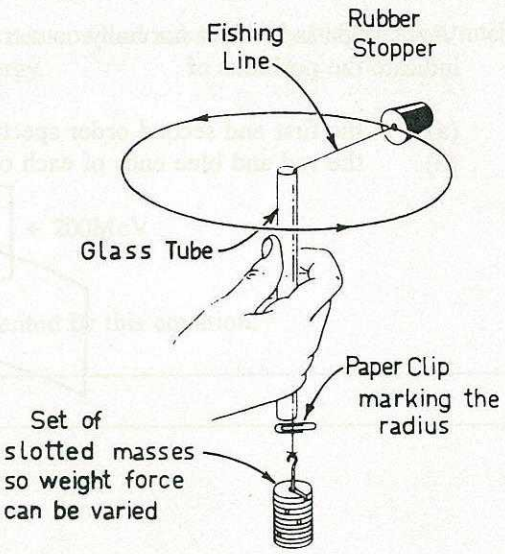
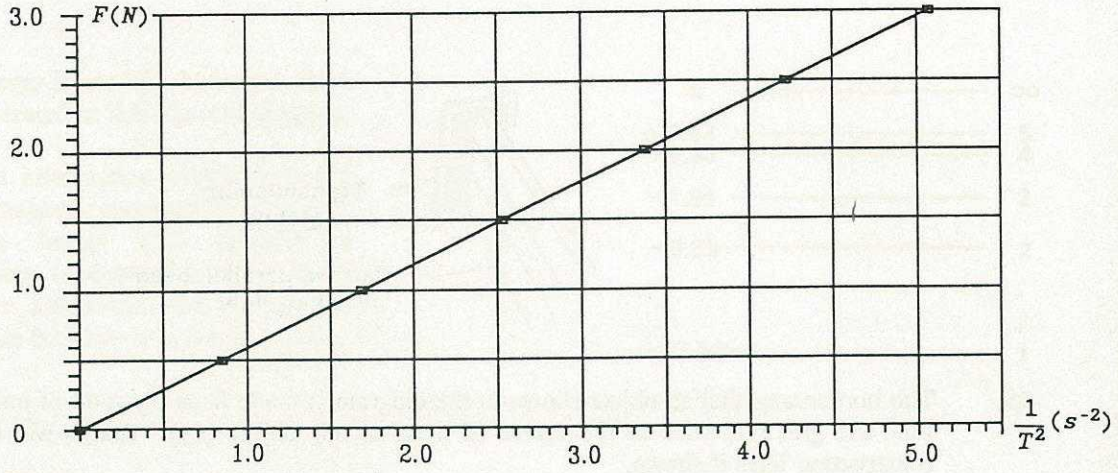
19. A group of students used the apparatus shown on the right to find the relationship between centripetal force (F) and the period of revolution (T).



Masses are added to provide the force required to keep the rubber stopper moving at constant speed around a circular path in an approximately horizontal plane.

The mass of the rubber stopper and the radius are kept constant for each trial.

Results are recorded and the force (F) is plotted against the inverse of the period of revolution squared $\left(\frac{1}{T^2}\right)$. The following plot is obtained.



(a) Determine the slope of this graph.

(b) If the radius of revolution of the rubber stopper is 0·300 m determine the mass of the rubber stopper.

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20. When an aeroplane flies overhead while you are watching television you will sometimes see the picture flicker at a fairly rapid rate. Use the diagram below and brief notes to explain what causes this flicker.

Aeroplane

T V Transmitter

House with T V aerial

SEE PAGE 16

For the next ten questions, choose which of the alternatives **best** answer the questions and indicate your choice by writing the appropriate letter in the box provided.

21. The electron volt is a unit of

A. energy.

B. force.

C. charge.

D. potential difference.

E. electric field strength.

22. Spherical aberration in lenses is a defect which arises because

A. it is not possible to grind the lens surfaces accurately spherical.

B. the refractive index of the glass of the lens is different for different wavelengths.

C. all the incident rays are not close to the principal axis.

D. perfect focus can only be achieved with a very large aperture.

E. the wavefronts of the incident light are not parallel.

23. If m is mass, g is the acceleration due to gravity, h is height and r is radius the expression $\frac{mg}{r}(2h-5r)$ is dimensionally consistent with

A. momentum.

B. power.

C. work.

D. force.

E. torque.

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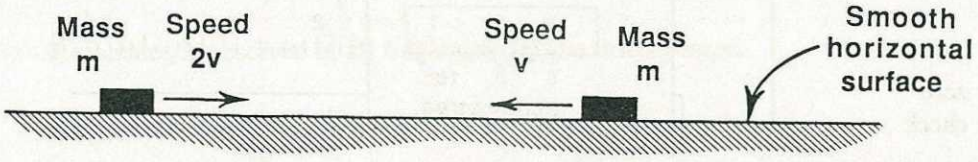
24. Two identical blocks slide towards one another along the same level line on a frictionless surface as shown below. One is sliding at twice the speed of the other.



If they collide elastically which of the following statements is correct?

A. The sum of the momenta before impact is 2 mv.

B. The sum of the momenta after impact is zero.

C. The sum of the kinetic energies after impact is zero.

D. The sum of the kinetic energies after impact is $\frac{5}{2}$ mv^2.

E. The sum of the momenta after the collision is 3 mv.

25. A planet is discovered that has four times the mass of Earth and twice the diameter. The acceleration due to gravity on this planet will be

A. four times that on Earth.

B. two times that on Earth.

C. the same as that on Earth.

D. half that on Earth.

E. $\frac{1}{\sqrt{2}}$ times that on Earth.

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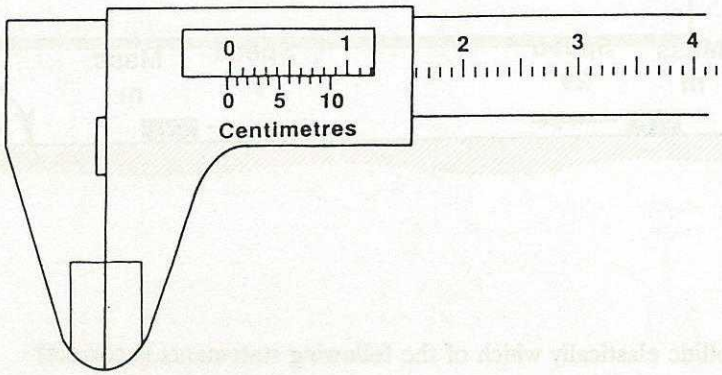
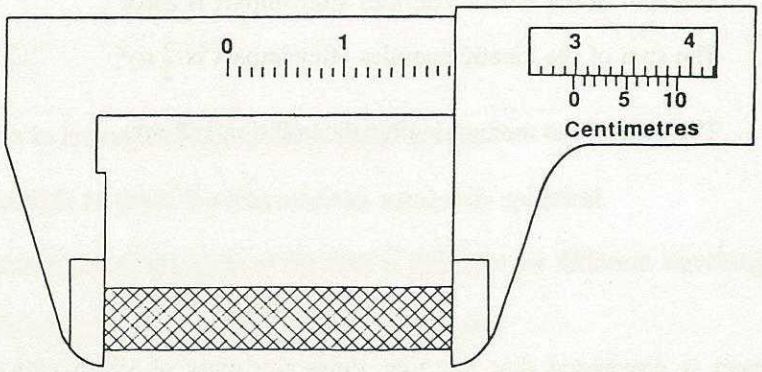
26. A student checks the zero on a worn pair of callipers before making a measurement. With the jaws fully closed the scales appear as shown in the figure below.

zero check



The student then measures the length of a piece of rod and obtains the result shown in the figure below.

taking the reading



What value should be recorded for the length of the rod?

A. 29·3 mm

B. 29·5 mm

C. 29· 9 mm

D. 30·3 mm

E. 30· 5 mm

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27. When speaking of forced vibrations in a resonant system, for example a pendulum, which one of the following is **NOT** true?

A. The amplitude of vibration is large because the driving force is always in phase (in step) with the resonant system.

B. Resonance is observed at all frequencies of the driving force.

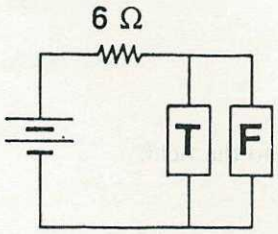
C. A resonant system can store energy.

D. A small amplitude of driving force can cause a large amplitude in a resonant system.

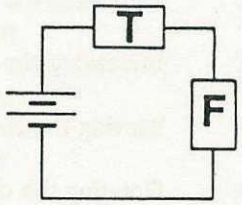
E. Resonance is a phenomenon put to use in many practical devices.

28. Tommy and Freda both have radios (T and F) which consume 3 W of power and are designed to run off 6 V. However, they only have a 12 V battery. Which of the following circuits would **NOT** be suitable to run both of their radios at the same time.

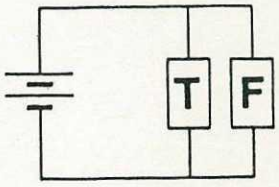
A.



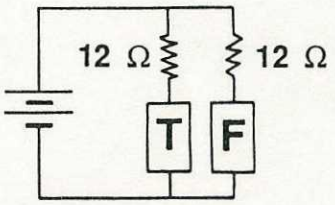
B.



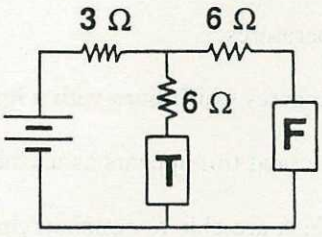
C.



D.



E.



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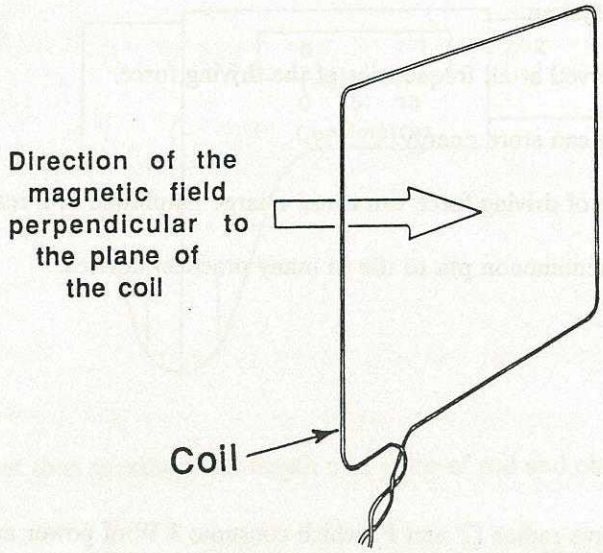
29. A coil is held perpendicular to a magnetic field as shown in the figure below.



Which of the following will decrease the amount of magnetic flux passing through the coil.

A. Increasing the magnetic field strength.

B. Increasing the area of the coil.

C. Moving the coil at constant velocity perpendicular to the field.

D. Rotating the coil through one quarter of a turn.

E. Increasing the number of turns of wire in the coil.

30. Fusion reactions produce large amounts of energy because

A. the reaction only takes place at very high temperatures.

B. hydrogen and its isotopes are very inflammable gases which burn with a hot flame.

C. binding energy is released when light nuclei fuse and this appears as useful energy.

D. the fusion reaction produces many neutrons which are able to sustain a chain reaction.

E. unlike the fission reaction, energy is not wasted in the form of radiation.

END OF SECTION A

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PHYSICAL CONSTANTS

The following physical constants should be used where necessary:

Acceleration due to gravity	$g = 9{\cdot}80 \text{ m s}^{-2}$
Speed of light in air	$c = 3{\cdot}00 \times 10^{8} \text{ m s}^{-1}$
Permittivity of free space	$\varepsilon_o = 8{\cdot}85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
Permeability of free space	$\mu_o = 4\pi \times 10^{-7} \text{ N A}^{-2}$
Electron charge	$e = -1{\cdot}602 \times 10^{-19} \text{ C}$
Mass of electron	$m_e = 9{\cdot}11 \times 10^{-31} \text{ kg}$
Planck's constant	$h = 6{\cdot}63 \times 10^{-34} \text{ J s}$
1 atomic mass unit	$u = 1{\cdot}661 \times 10^{-27} \text{ kg}$
Refractive index of air	$n_a = 1{\cdot}00$
Universal gravitational constant	$G = 6{\cdot}67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Mean radius of the Earth	$r_E = 6{\cdot}37 \times 10^{6} \text{ m}$
Mass of the Earth	$M_E = 5{\cdot}98 \times 10^{24} \text{ kg}$
1 tonne	$= 1{\cdot}00 \times 10^{3} \text{ kg}$
1 eV	$= 1{\cdot}60 \times 10^{-19} \text{ J}$