SEA SECONDARY EDUCATION AUTHORITY (WA)

TERTIARY ENTRANCE EXAMINATION, 1988

QUESTION/ANSWER BOOKLET

PHYSICS

Please place one of your student identification labels in this box

STUDENT NUMBER—In figures

In words

TIME ALLOWED FOR THIS PAPER

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

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

See Page 2

INSTRUCTIONS TO CANDIDATES

This paper consists of TWO (2) sections.

In SECTION A, answer ALL thirty questions, and **write your answers in the spaces provided beneath each question.** This section carries 48% of the total marks for the paper. Each of these questions is of equal value.

In SECTION B, answer ALL questions, and write your answers in the Question/Answer Booklet provided. This section is worth 52% of the total marks for the paper.

In both sections, note that all answers should be given numerically where possible, and that numerical answers 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 label to the front cover of this Question/Answer Booklet. Write your student number in the spaces provided in the Question/Answer Booklet.

REFER TO PAGE 35 FOR PHYSICAL CONSTANTS

NOTE: Page 35 is perforated and may be removed for easier use during the examination.

SEE PAGE 2

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR

This Question/Answer Booklet comprising 35 pages (Section A — 30 questions, Section B — 8 questions)

TO BE PROVIDED BY THE CANDIDATE

Standard Items

Pens, pencils, eraser, ruler

Special Items

Hood & Storer Mathematical & Statistical Tables, Source Book of Chemical Data, OR the Combined Book of Mathematical & Statistical Tables and Chemical Data, a calculator satisfying the conditions set by the Secondary Education Authority, compass, protractor and set square.

NOTE: Personal copies of Tables/Chemical Data 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.

SEE PAGE 3

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 provided for each question 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 35.

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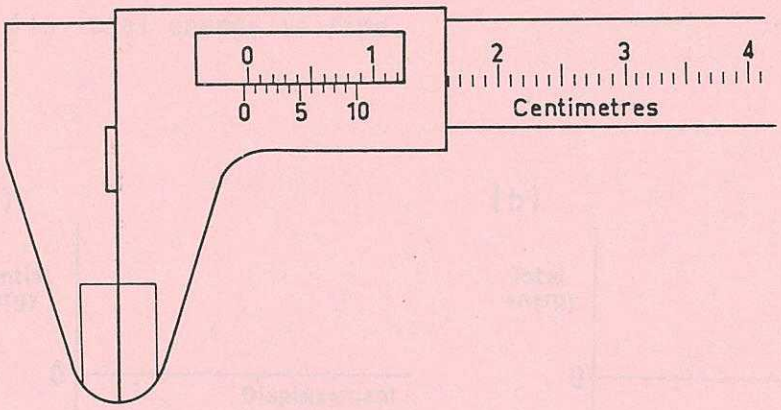
1. A student checks the zero on a worn pair of calipers before making a measurement and with the jaws fully closed the scales appear as in the figure below.

   (a) What is the zero error?

   (b) If an apparent measurement is X mm, what is the correct value taking into account the zero error? The small divisions on the main scale represent mm.



2. What maximum torque can be exerted by a mechanic unscrewing a small nut using a spanner whose length is 305 mm if the maximum force he can exert on the end of the spanner is 592 N?

SEE PAGE 4

3. A car is travelling due east at 25·0 m s^{-1} and rounds a right angled bend so that it travels on at the same speed due north. Draw a vector diagram to show the magnitude and direction of

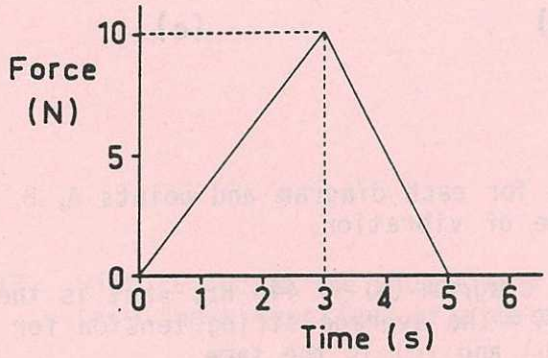
   (a) the initial and final velocities and

   (b) the total change in velocity due to rounding the corner.

4. A plane flying at 900 kilometres per hour loops the loop. What must the radius of the loop be so that the maximum force of the pilot on her seat is 6·00 times her weight?

SEE PAGE 5

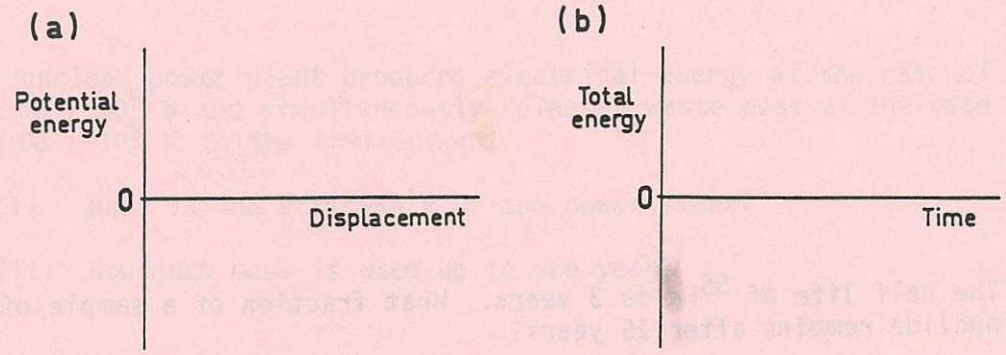
5. The graph shows how a force acting on a body of mass 2·00 kg (initially at rest) varies with time. What is the total change in momentum of the body after 5·00s have elapsed?



6. A ball is thrown vertically upwards, rises to a height h and then falls back to the ground. Sketch graphs to show the variation of

(a) its potential energy vs its displacement,

(b) its total energy vs time.

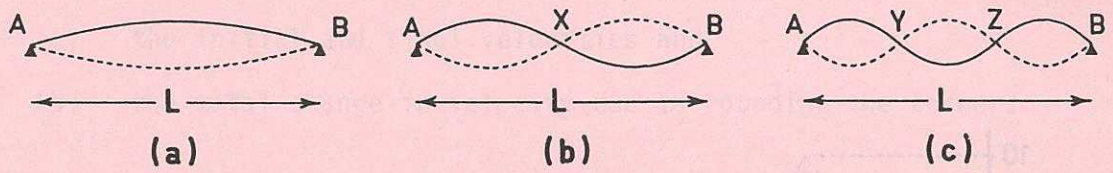


7. (a) Define the term "absolute refractive index".

(b) Hence or otherwise explain why its value cannot be less than 1.

SEE PAGE 6

8. A stretched string may vibrate in a number of ways. Three possible ways are shown in the diagrams.



The distance between A and B is L for each diagram and points A, B, X, Y and Z are nodes for this type of vibration.

If the frequency of the string in diagram (a) is 446 Hz, what is the frequency for diagrams (b) and (c)? The average string tension for the vibrations in diagrams (a), (b) and (c) is the same.

9. A camera is focussed on a group of people 3·05 m from the lens which has a focal length of 50·0 mm.

What is the distance between the lens and the film?

10. The half life of ^{55}Fe is 3 years. What fraction of a sample of this nuclide remains after 15 years?

SEE PAGE 7

11. List four (4) distinct properties of gamma radiation.

12. With regard to the photoelectric effect explain what is meant by the term "work function" of a metal.

13. A nuclear power plant produces electrical energy at the rate of $1{\cdot}00 \times 10^9$ W and simultaneously releases waste heat at the rate of $2{\cdot}00 \times 10^9$ W to the environment.

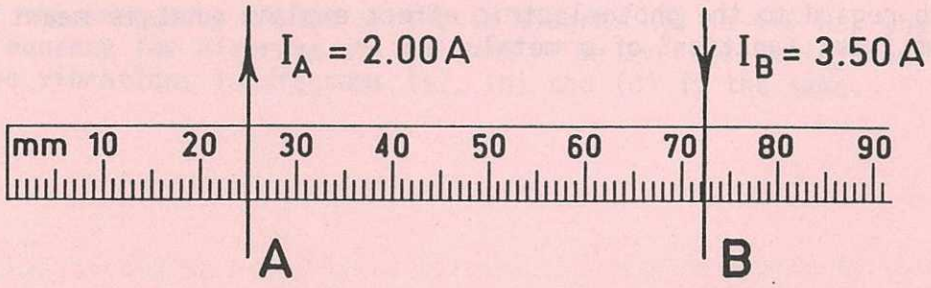
    (i) What is the efficiency of the power plant?

    (ii) How much mass is used up in one year?

SEE PAGE 8

14. At what distance apart must two negative charges of $3{\cdot}00 \times 10^{-6}$ C be placed if there is to be a force of 1·50 N on each?

15. Two parallel straight conductors cross a metre rule perpendicularly as shown.



What is the force per unit length (in N m^{-1}) on wire A? State magnitude and direction.

16. A car headlamp is rated at 48·0 W and is designed to run off a 12·0 V battery.

(a) What current flows through the headlamp?

(b) What resistance does the headlamp have under normal operating conditions?

SEE PAGE 9

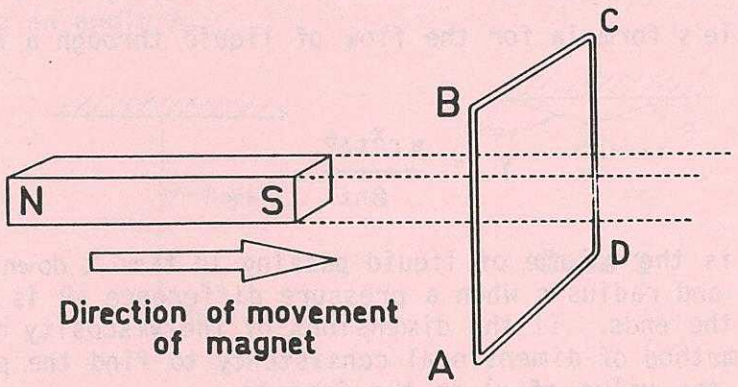
17. If a small sphere carries a negative charge of 4·00 nanocoulomb, how many excess electrons does it have?

18. A bar magnet passes through the centre of a rectangular loop of copper wire as shown.

(a) What is the direction of the induced current as the magnet approaches the loop? Choose either ABCD or DCBA.

(b) What is the direction of the induced current as the magnet moves away from the coil after having passed completely through it? Choose either ABCD or DCBA.

(c) In case (a), do the magnet and coil attract or repel each other?



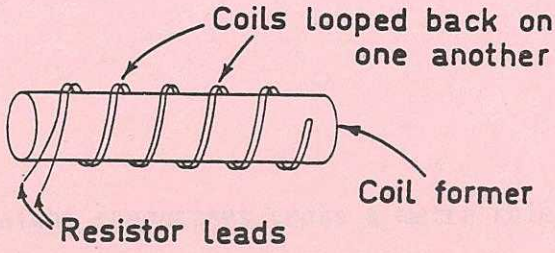
(a) _____

(b) _____

(c) _____

SEE PAGE 10

19. In the manufacture of wire wound resistors, the coils of the resistors are wound by doubling each coil back on itself as shown. Suggest why this might be done.



20. Poiseuille's formula for the flow of liquid through a narrow tube is

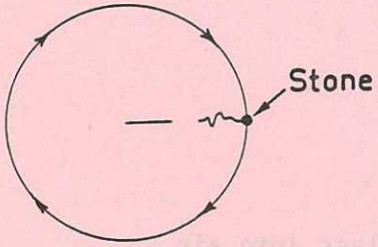
$$V = \frac{\pi r^x t \Delta P}{8 \eta \ell}$$

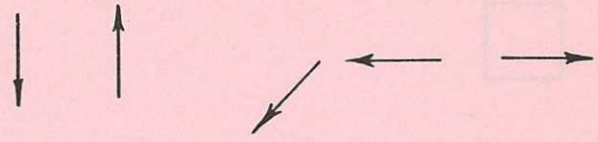
where V is the volume of liquid passing in time t down a pipe of length ℓ and radius r when a pressure difference ΔP is maintained between the ends. If the dimensions of the viscosity η are $ML^{-1}T^{-1}$ use the method of dimensional consistency to find the power of r (that is the value of x) in the formula.

SEE PAGE 11

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. A boy is whirling a stone on a string. If the string breaks at the instant shown in the diagram, the arrow which best represents the direction the stone now takes is

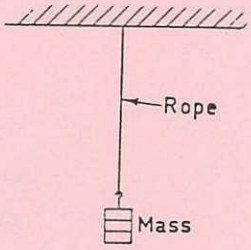




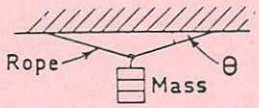
A B C D E

22. A mass m, when hung vertically on a rope as shown in Case 1, does not break the rope.

The same rope is then tied at both ends to two horizontal points so that the rope is straight and level. The same mass is hung from the centre of the rope as shown in Case 2 and the rope breaks after deflecting an angle θ.



Case 1



Case 2

The tension in the rope in Case 2 is greater than in Case 1 and the rope breaks because

A. the tension is equal to twice the weight of the attached mass.

B. the tension in either side of the rope = $\frac{1}{2}(mg/\cos\theta)$. Since θ is a small angle its cosine is small and the tension is very large.

C. the resolved components of the tensions in the vertical direction are small and the tension in the rope must be very large in comparison to the weight of the attached mass.

D. the tension has to support the mass of the rope as well as that of the attached mass.

SEE PAGE 12

23. The image of a real object formed by a diverging lens is always

A. real.

B. virtual.

C. larger than the object.

D. inverted.

24. When light is refracted in passing from glass into air

A. its speed increases and its wavelength increases.

B. its speed increases and its frequency increases.

C. its wavelength increases and its frequency increases.

D. its speed decreases and its wavelength decreases.

E. its wavelength increases and its frequency decreases.

25. Photoelectrons are emitted by a metallic surface only when the light directed at it exceeds a certain minimum

A. wavelength.

B. frequency.

C. charge.

D. speed.

SEE PAGE 13

26. As a sample of radioactive $^{32}_{15}P$ decays, its half life

A. decreases.

B. increases.

C. remains the same.

D. depends on its locality on the earth's surface.

27. The final velocity in m s^{-1} of an electron of mass m and charge e accelerated from rest through a small potential difference of V volts is

A. $\sqrt{2eV/m}$.

B. $2eV/m$.

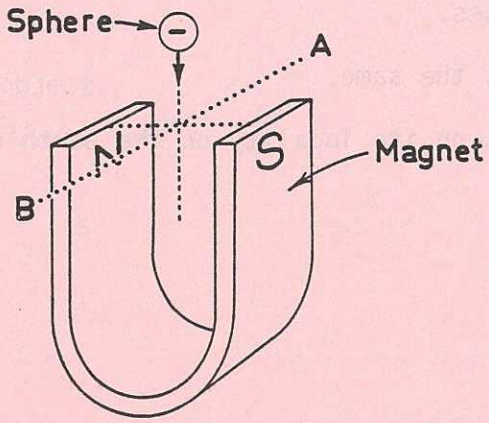
C. $\frac{V}{2}\sqrt{e/m}$.

D. eV/m .

E. $V\sqrt{2e/m}$.

SEE PAGE 14

28. If a negatively charged sphere is allowed to drop between the poles of a strong horseshoe magnet as shown in the diagram, the sphere will



A. be deflected towards the N pole.

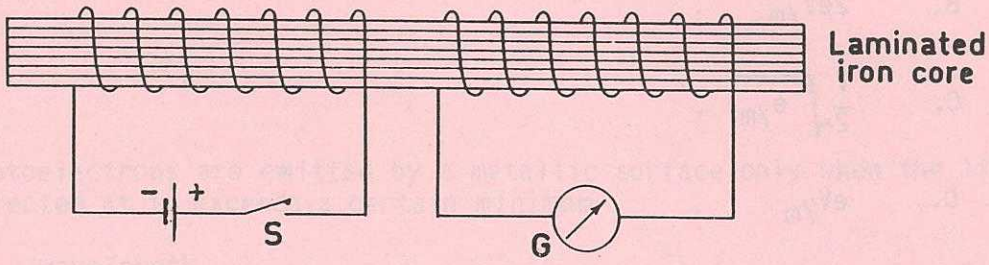
B. be deflected towards the S pole.

C. be deflected towards A

D. be deflected towards B.

E. pass through unaffected by the field.

29. When the switch S is operated, the galvanometer G will show a deflection



A. while the switch is on.

B. while the switch is off.

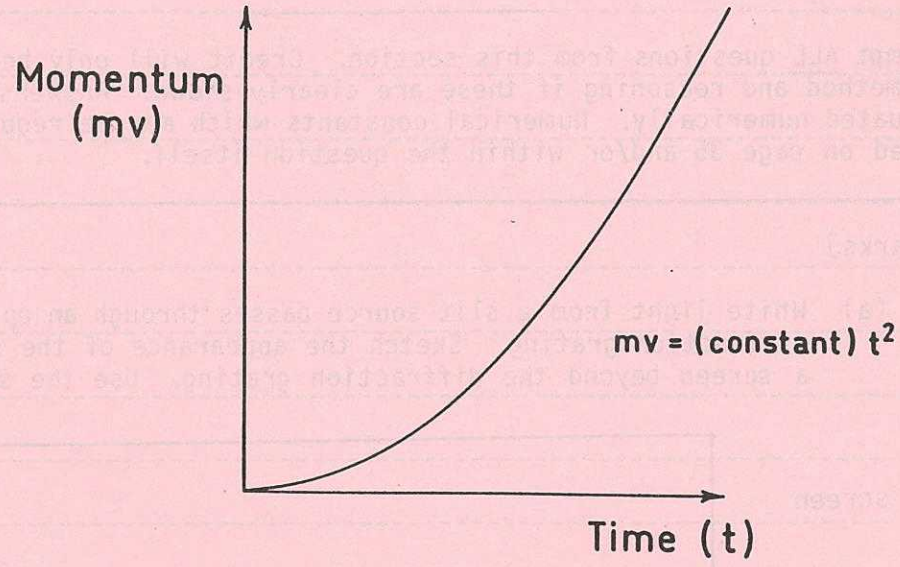
C. only at the instant the contact is made.

D. only at the instant the contact is broken.

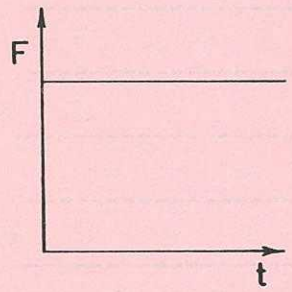
E. at both the instant the contact is made and the instant at which it is broken.

SEE PAGE 15

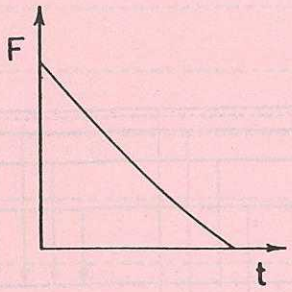
30. The momentum of a body which is acted on by a force varies with time as shown.



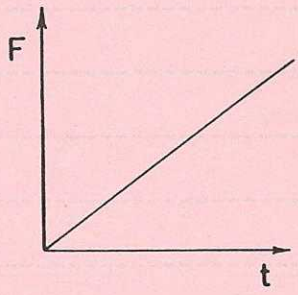
The graph which best illustrates the way the force varies with time is



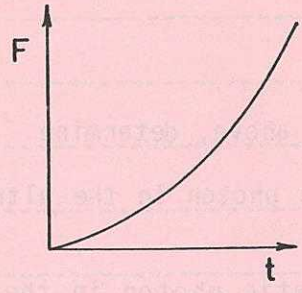
A



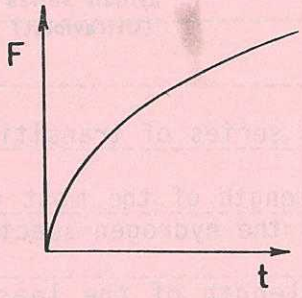
B



C



D



E

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SECTION B

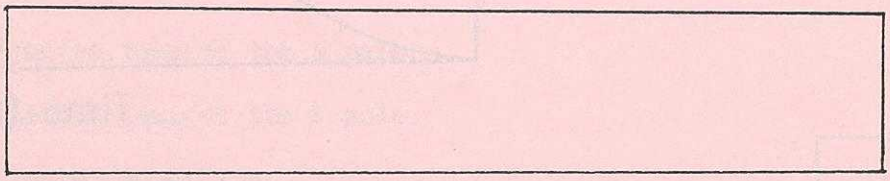
MARKS ALLOTTED : 52

Attempt ALL questions from this section. Credit will only be obtained for method and reasoning if these are clearly shown. Answers should be evaluated numerically. Numerical constants which may be required are listed on page 35 and/or within the question itself.

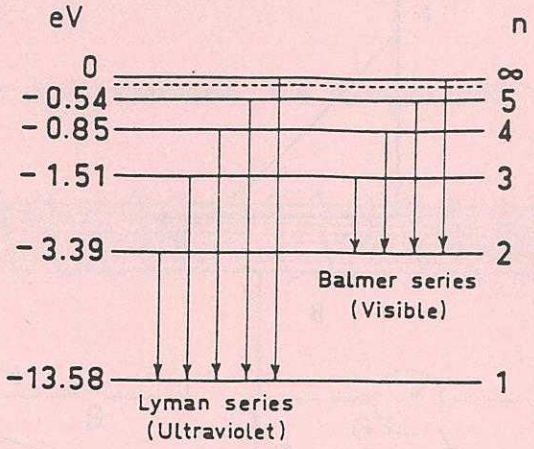
[6 marks]

1. (a) White light from a slit source passes through an optical diffraction grating. Sketch the appearance of the spectrum on a screen beyond the diffraction grating. Use the screen below.

screen



The following energy level diagram for hydrogen is required to answer parts (b) and (c).



Using the series of transition lines above, determine

(b) the wavelength of the most energetic photon in the ultra-violet region of the hydrogen spectrum,

(c) the wavelength of the least energetic photon in the visible region of the hydrogen spectrum.

(d) What is the explanation for hydrogen gas burning with a blue flame?

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[6 marks]

2. (a) Explain the difference between fission and fusion.

(b) Ordinary water consists of a small amount of "heavy water" in which the two hydrogen atoms are replaced with deuterium atoms ($^{2}_{1}H$). In fact, 1·00 litre of water contains $5{\cdot}02 \times 10^{21}$ molecules of "heavy water".

What fusion power is available if all the $^{2}_{1}H$ in one litre of water burn daily through the reaction

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n$$

The masses of the particles involved are -

$^{2}_{1}H$ = 2·014102 atomic mass units.

$^{3}_{2}He$ = 3·016049 atomic mass units.

$^{1}_{0}n$ = 1·008665 atomic mass units.

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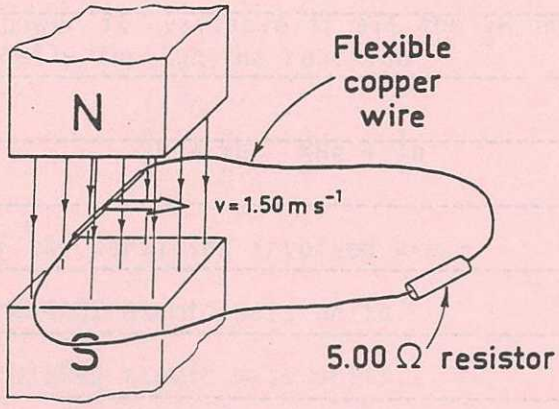
[7 marks]

3. A rigid piece of copper wire whose length is 72·4 mm is connected to two flexible pieces of wire which are in turn connected to either end of a 5·00 Ω resistor as shown below. Assume the length of the rigid wire is the same as the width of the magnetic field.



The rigid piece of wire is being moved uniformly through the magnetic field as shown. If it is moving at 1·50 m s^{-1} and the magnetic field intensity is 2·58 T, determine

(a) the emf generated,

(b) the power dissipated in the resistor,

(c) the magnitude of the magnetic force on the rigid wire due to its motion in the field,

(d) the rate that the applied force does work.

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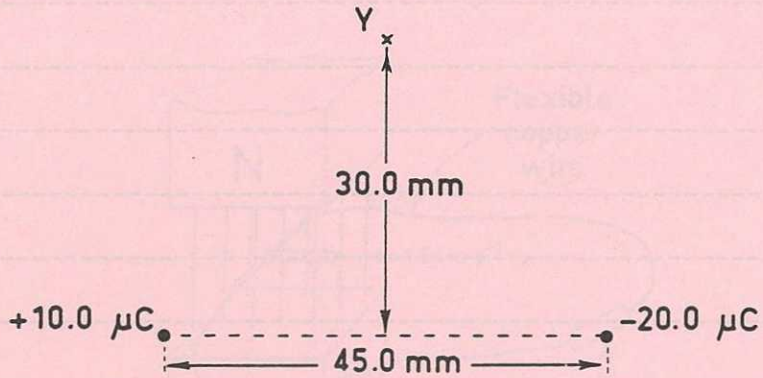
[6 marks]

4. Two charges, one of +10·0 μC and one of −20.0 μC are placed 45·0 mm apart in air as shown below.



Find the magnitude and direction of the force on a +5·00 μC charge placed at point Y, which is 30·0 mm from the mid point of the line joining the two charges and perpendicular to it.

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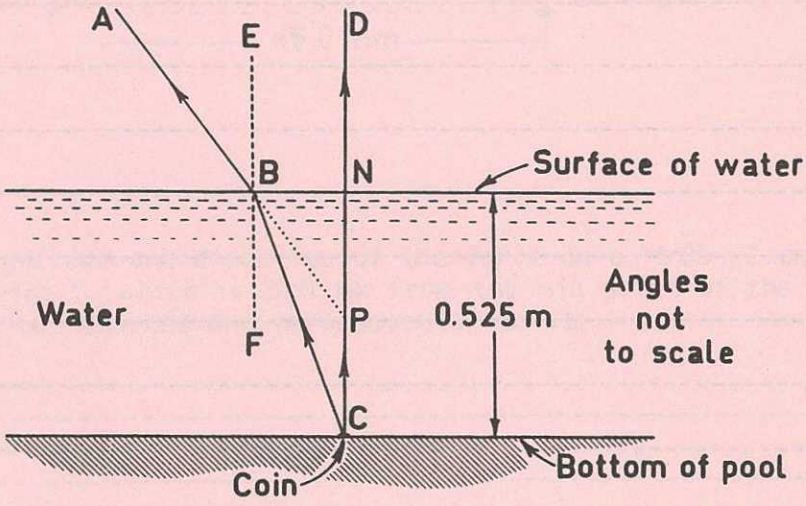
[7 marks]

5. A small coin rests on the bottom of a pool of water which is 0·525 m deep.

A person views this coin from a point directly above the coin.

For the diagram shown, rays BA and ND enter the eye of the person viewing the coin and an image of the coin is seen at P. The ray ND emerges normal to the surface of the water. On the diagram EF has been drawn as the normal at B.

(a) Calculate the value of angle ABE given that the refractive index of the water is 1·33 and the angle of incidence FBC is $0{\cdot}295^{o}$.



(b) Determine the apparent distance to the coin from the surface of the water, that is the distance NP.

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[6 marks]

6. In an experiment to determine the acceleration due to gravity, a group of students time the free fall of a heavy metal sphere from a third floor window to the ground below. The height through which the sphere falls was determined by a single measurement with a tape measure as being 11·8 m and a number of trials timing the fall with a handheld stopwatch gave the following for the time of fall of the sphere:

Trial	1	2	3	4	5	6	7	8	9
Time (s)	1·55	1·66	1·43	1·58	2·31	1·64	1·49	1·51	1·61

(a) Use this data to calculate the value of "g" the students would get for their experiment using the relationship height $s = \frac{1}{2}gt^2$ where s is height and t is time.

(b) Make an estimate, as if you had performed the experiment, for the error in the value of "g" found from the experiment.

(c) In the light of your answer to (b), suggest briefly two modifications to improve the precision of the determination of "g".

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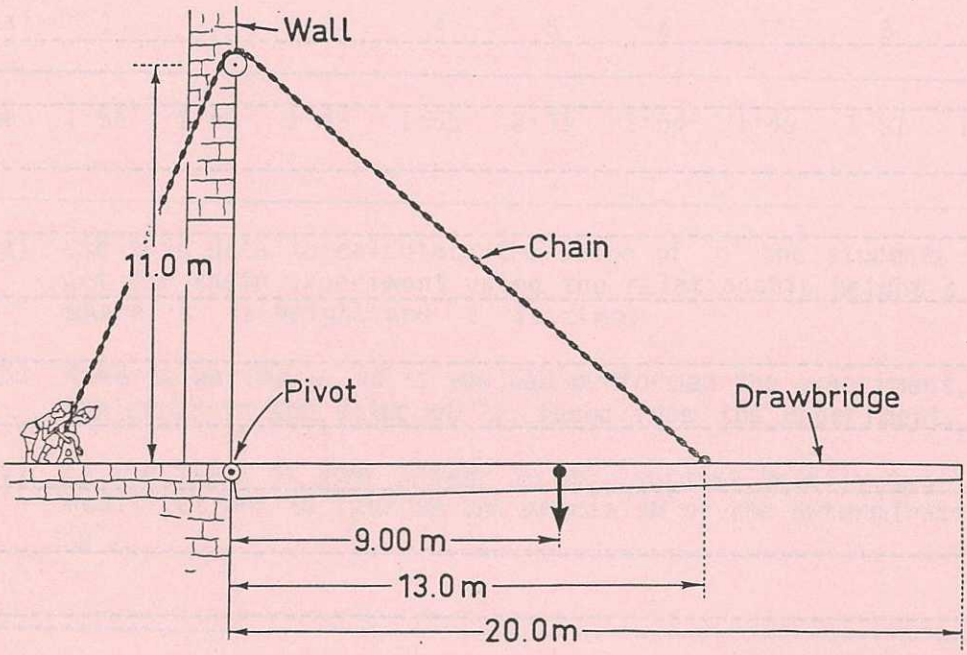
[7 marks]

7. A drawbridge of a castle is 20·0 m long and has a mass of $3{\cdot}00 \times 10^3$ kg. It is pivoted to the wall of the castle at one end and supported by means of a chain attached to the bridge at a point 13·0 m from the pivot. The chain runs over a pulley mounted 11·0 m above the pivot point. The centre of mass of the drawbridge is 9·00 m from the pivot.



(a) What is the tension in the chain when the drawbridge is at rest in the horizontal position? (Hint: take moments about the pivot).

(b) On the diagram sketch a vector to indicate the direction of the force acting at the pivot on the drawbridge.

(c) How does the direction of the force at the pivot change as the drawbridge is raised?

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[7 marks]

8. The earth rotates on its axis once in 24·0 hours. A satellite is to be placed in a circular geostationary orbit above a point on the earth so that it will always be directly above that point.

(a) Calculate the height of the orbit above the surface of the earth.

(b) Sketch the orbit around the earth for a case where the satellite is stationary above a point on the equator.

(c) Is it possible to place a satellite in such an orbit so that it always remains directly above a place like Perth which is **not** on the equator? If so, sketch the orbit.

END OF PAPER

SEE PAGE 35 FOR THE PHYSICAL CONSTANTS