DEPARTMENT OF EDUCATION

UPPER SECONDARY SCHOOL CERTIFICATE EXAMINATIONS

PHYSICS

Wednesday

16 October 2013

Time allowed:
2 hours and 30 minutes
(8:00 am – 10:30 am)

NO EXTRA TIME
(NO OTHER TIME)

Candidates are advised to fully utilise the allocated time.

P

INSTRUCTIONS TO CANDIDATES

To be read by the external invigilator to all candidates

1. The subject code Physics is **7**
2. There are **15** printed pages in the question booklet.
3. There are **11** printed pages in the Section B Answer Booklet and a Part A Electronic Answer Sheet. They are inserted in the middle of your Question Booklet.
4. There are two sections in this paper.

   Section A: Multiple Choice Questions - 30 marks
   This section will be electronically marked.
   All answers to the Multiple Choice Section MUST be answered on the Electronic Answer Sheet.
   Carefully following the instructions, fill in your Candidate Information and Subject Information.

   Section B: Short Answer Questions - 70 marks
   Write down your name, your school name and your10 digit candidate number on the Section B Answer Sheet Provided.
5. You are required to only write the correct answer in the space provided.
6. Calculators may be used.
7. Answers written on the question paper will not be marked. Write answers neatly in spaces as allocated on the answer sheet. Answer **ALL** questions.
8. Answer all questions on the answer sheet. Answers on any other paper including rough work paper and the question paper **will not be marked**
9. ALL working must be shown step by step to get full marks. Students may lose marks for writing down final answers only.
11. Correctional Fluid is not allowed on the answer sheet. Where you have made an error, cross out all the working and start on a new line.
12. Graphical Calculators are not permitted.

PENALTY FOR CHEATING OR ASSISTING TO CHEAT IN NATIONAL EXAMINATIONS IS NON-CERTIFICATION.

DO NOT TURN OVER THE PAGE AND DO NOT WRITE UNTIL YOU ARE TOLD TO START.

SECTION A: MULTIPLE CHOICE (QUESTIONS 1 to 30) 30 MARKS

Answer each question by shading in with HB pencil, the circle directly under the correct alternative A, B, C, D or E. If you make a mistake, rub it out completely using an eraser and shade the correct answer on the Electronic Answer Sheet.

QUESTION 1

A particle has a speed of 100mm/ms. In SI units the speed of the particle is:

A. 0.01m/s B. 0.1m/s C. 1m/s D. 10m/s E. 100m/s

QUESTION 2

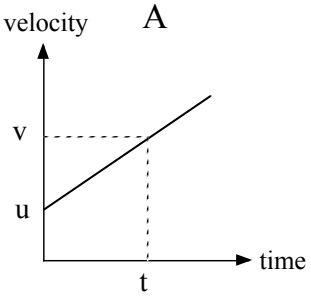
The circumference of a circle has the same dimension as

A. Mass B. Time C. Length D. Area E. Volume

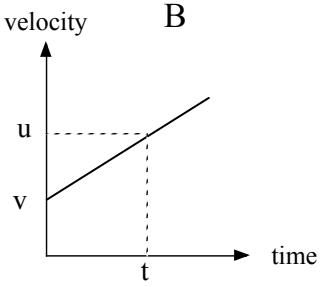
QUESTION 3

A particle moves in the positive x-direction with a positive constant acceleration. At time t = 0, its velocity is u and at time t its velocity is v. Assuming air resistance is negligible, the graph which correctly describes the motion of the particle is

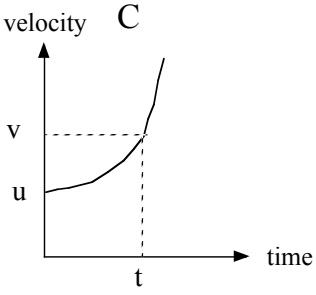
A



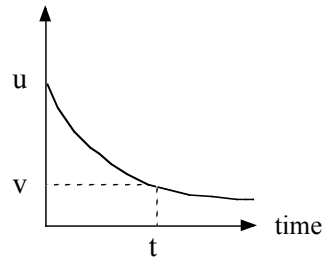
B



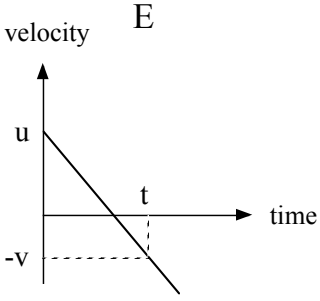
C



D



E



QUESTION 4

An object moving with constant acceleration changes its velocity from 10m/s to 20m/s in five seconds. The distance traveled in five seconds is

A. 75 m B. 100 m C. 150 m D. 50 m E. 60 m

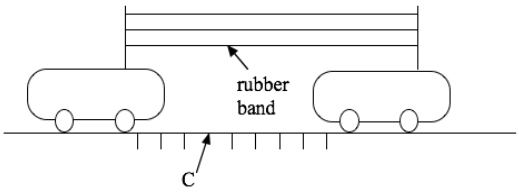
QUESTION 5

A marble is projected horizontally off the edge of a table with a velocity of 150m/s. Assuming air resistance is negligible, what would be its horizontal velocity when the marble strikes the ground?

A. - 200m/s B. - 150m/s C. 200m/s D. 150m/s E. 100m/s

QUESTION 6

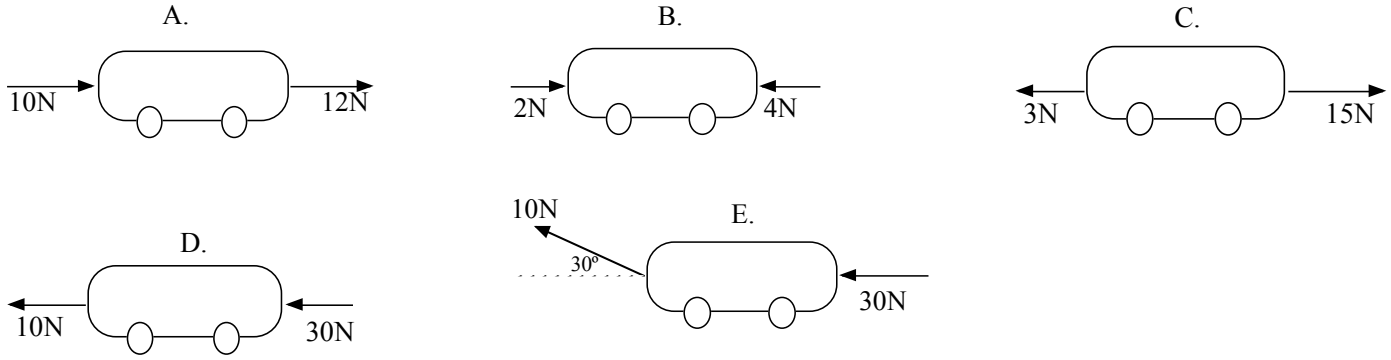
Suppose 2 low friction trolleys are connected by a stretched rubber band and then released. They then collide at point C. As soon as this experiment is over, the students make the following comments:



A. The rubber band exerts unequal forces on the trolleys.
B. Trolley A was traveling faster than trolley B
C. Trolley A has more mass than trolley B
D. Trolley B was traveling at the same speed than trolley A
E. Trolley B has more mass than trolley A

QUESTION 7

Which of the following identical trolleys will have the greatest acceleration?



QUESTION 8

Supposing a small rocket pushes out 3kg of exhaust gas every second at a velocity of 80m/s. The thrust generated is

A. 24 N B. 24O N C. 80 N D. 2400 N E. 100 N

QUESTION 9

A machine has power input of 5 000 watts and power output of 2 800 watts. What is the efficiency of the machine?

A. 50% B. 54% C. 56% D. 64% E. 65%

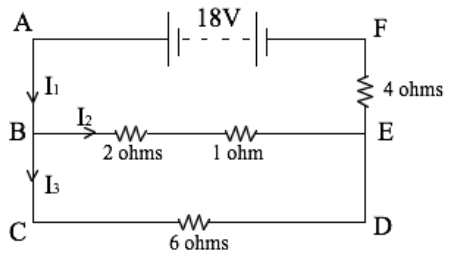
QUESTION 10

A 2000 kg spacecraft is taking off from the moon's surface at a steady velocity. At a height of 500m, the engines are cut off and it falls freely to the moon's surface. Take the moon's gravitational field strength (g) as 1.67 N/kg.

Determine the potential energy the spacecraft gained at maximum height before falling.

A. 1.67×10^6 J B. 2.6×10^5 J C. 3.6×10^4 J D. 4.6×10^3 J E. 5.6×10^2 J

For Question 11 and Question 12 refer to the circuit diagram below.



QUESTION 11

What is the total resistance between the points BCDEB?

A. 3 Ω B. 9 Ω C. 2 Ω D. 0.5 Ω. E. 4 Ω

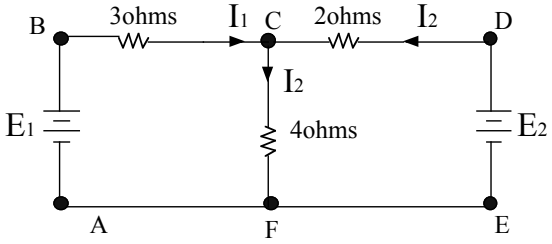
QUESTION 12

What is the power dissipated in the 1Ω resistor?

A. 4W B. 6W C. 9W D. 12W E. 24W

QUESTION 13

For the circuit shown what is the loop equation for the loop on the left hand side?

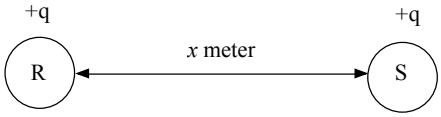


A. $I_1 + I_2 = I_3$ B. $3I_1 - 4I_3 = 10$ C. $E_1 - 3I - 4I_3 = 0$

D. $2I_2 + 4I_3 = 2$ E. $2 - 2I_2 - 4I_3 = 0$

QUESTION 14

R and S are identical, insulated, metal balls situated *x* meters apart and carrying equal electrical charges of +*q* coulombs. The force that each exerts on the other is 6.0 x 10^{-4} N.



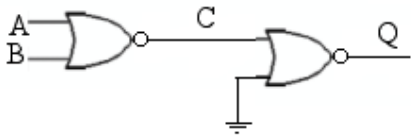
If the balls are now separated by a distance of 2*x* meters the force exerted on each is

A. 1.5 x 10^{-4} N B. 3.0 x 10^{-4} N C. 6.0 x 10^{-4} N

D. 3.6 x 10^{-3} N E. $\sqrt{6}$ x 10^{-2} N

QUESTION 15

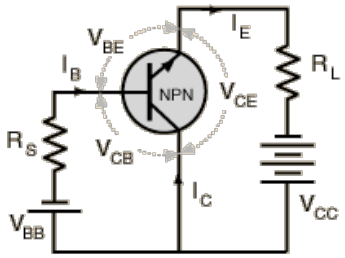
What type of gate is this arrangement equivalent to?



A. NOR B. XOR C. NAND D. AND E. OR

QUESTION 16

What type of amplifier configuration is the circuit shown?

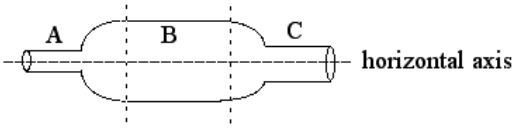


A. Common base B. Common emitter C. Class B amplifier

D. Common collector E. Differential amplifier

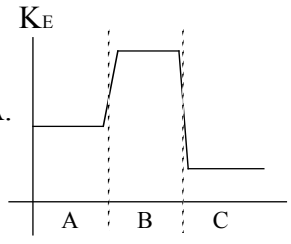
QUESTION 17

Water flows smoothly though 3 different sections labeled A, B and C of a horizontal pipe as shown.

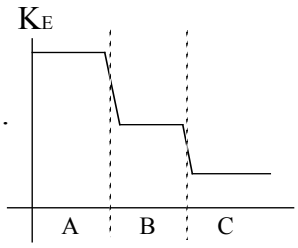


Select the graph that best represents the Kinetic energy K_E of a water element as it moves along the horizontal axis from section A to C.

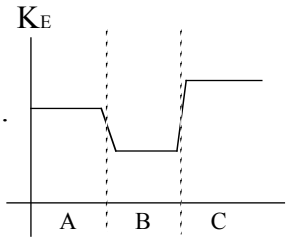
A.



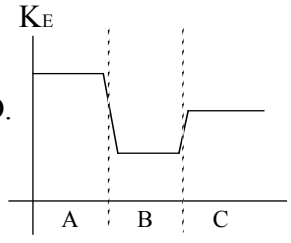
B.



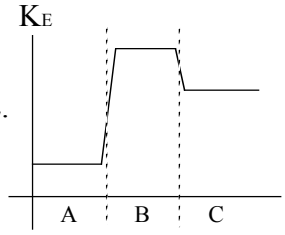
C.



D.



E.



QUESTION 18

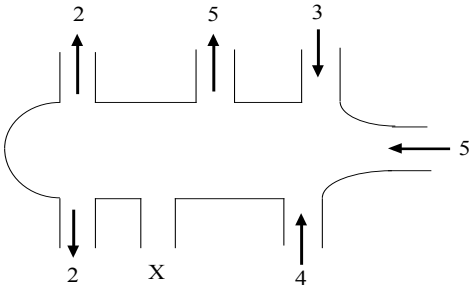
The 2 thighbones each of cross-sectional area $10cm^2$ support the upper part of a human body of mass 40kg. Calculate the pressure sustained by the bones.

A. 1×10^6 N/m^2 B. 8×10^5 N/m^2 C. 4×10^5 N/m^2

D. 2×10^5 N/m^2 E. 1×10^5 N/m^2

QUESTION 19

Liquid is flowing in and out of a conduit as shown. The direction of flow at the inlets and outlets are indicated by the arrows as well as the flow rate in m^3/s.



The unknown flow rate X in m^3/s is

A. 3 in B. 3 out C. 4 in D. 5 in E. 2 out

QUESTION 20

What is true of a constant temperature process?

A. $\Delta T > 0$ B. $\Delta U = 0$ C. $\Delta Q = \Delta W$ D. PV = constant E. $\Delta U > 0$

QUESTION 21

Trapped air of volume 4 m³ has a pressure of 3 atm when its temperature is 27 ºC.
What will be the pressure if it is compressed into half the volume and heated to 127 ºC?

A. 28.22 atm B. 8 atm C. 4 atm D. 2.54 atm E. 110.16a atm

QUESTION 22

A 100 Watt electric heater is inserted into a breaker containing 0.5 kg of a liquid and is switched on for 230 seconds. The temperature of the liquid rises by 10ºC.
Assume no thermal energy lost to the surroundings, what is the specific heat capacity of the liquid?

A. 23 000 J/ (kgºC) B. 1 625 J/ (kgºC) C. 23 000 J/(kg ºC)

D. 4 600 J/ (kgºC) E. 460 J/(kgºC)

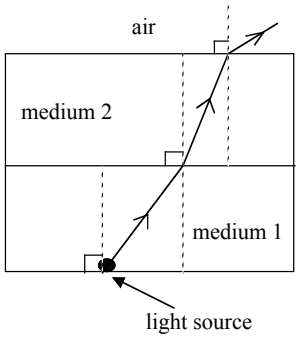
QUESTION 23

Which of these sentences best describes the application of waves in radar applications to detect an aircraft?

A. A radar uses the echo –sounder principle but with microwaves instead of sound waves.
B. A radar uses the echo – sounder to detect aircrafts.
C. A radar uses echo sounder pulses in aircraft detection.
D. A radar uses electromagnetic pulses in kilohertz range to detect an aircraft.
E. A radar uses light waves to detect aircrafts.

QUESTION 24

The diagram below shows the path of a ray of light from a point source in medium 1 entering medium 2 and emerging into the air.



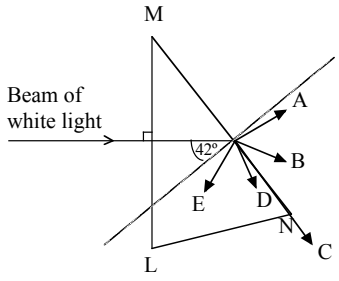
If the speed of light is v_1 in medium 1, v_2 in medium 2 and v_a in air then which of the following statements is correct?

A. $v_1 > v_2 > v_a$ B. $v_1 > v_a > v_2$ C. $v_a > v_1 > v_2$

D. $v_2 > v_1 > v_a$ D. $v_2 > v_a > v_1$

QUESTION 25

A beam of white light passes into a glass prism LMN and strikes the surface MN at an angle of incidence of 42°. The angle 42° is the critical angle for green light.



Along which two paths will the green component of the white light travel?

A. OA and OE B. OB and OE C. OC and OE

D. OD and OE E. OD and OB

QUESTION 26

A uniform magnetic field B, with magnitude 1.2m T is directed vertically upward throughout the volume of a laboratory chamber. A proton traveling at a velocity of 3.2 x10^7m/s, moves horizontally from south to north. What magnetic deflecting force acts on the proton as it enters the chamber?

A. 6.1 x 10^{-14} N B. 6.1 x 10^{-15} N C. 6.1 x 10^{23} N

D. 6.1 x 10^{-29} N E. 6.1 x 10^{-9} N

QUESTION 27

A small transformer connected to a 120V power supply produces a voltage of 9.2V and a current of 0.02 A to power a toy car. What is the ratio of primary windings to secondary windings in the transformer?

A. 1:3 B. 1: 4800 C. 13:1 D. 4800:1 E. 13:4800

QUESTION 28

The power loss in a transmission line is proportional to the square of the current. When the current carried by a transmission line increases from I to 2I (doubled), the power loss in the transmission line

A. increases by a factor of 2. B. decreases by a factor of 2. C. increases by a factor 4.

D. decreases by a factor of 4. E. increases by a factor of $\sqrt{2}$.

QUESTION 29

Which of the following atoms have the same mass as an alpha particle?

A. Hydrogen B. Helium C. Nitrogen D. Oxygen E. Carbon

QUESTION 30

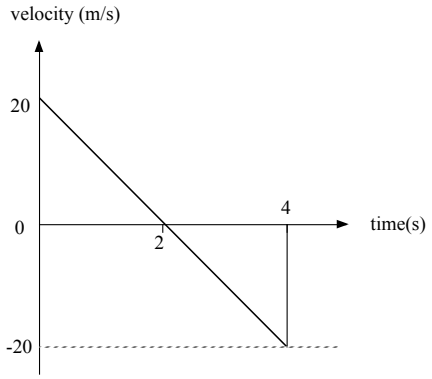
In 2012 scientists dug up ancient skeletal remains of a human being. They wanted to carry out tests to determine the age of the bones. The most suitable radioactive isotope for this kind of work is

A. Radium-226 B. Uranium-238 C. Thorium-234 D. Carbon -14 E. Carbon -12

SECTION B: SHORT ANSWER (QUESTIONS 31 to 40) 70 MARKS
Write your answer to the questions in the spaces provided in your Part B Answer Booklet.

QUESTION 31

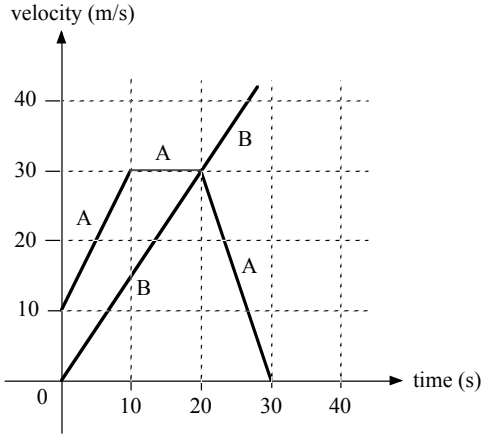
a) A ball is thrown vertically upwards and returns to the thrower. The graph of the motion of the ball is shown. (Ignore air resistance)



i) At what time does it reach maximum height? (1 mark)

ii) What is the magnitude of the ball's displacement? (1 mark)

b) A velocity-time graph is shown below for a car (A) and motorcycle (B), traveling on a racetrack. At t = 0 s, the car and the motorcycle are together at the same point.



i) What is the magnitude of the car's acceleration at t = 25 s? (2 marks)

ii) At what speed will the motorcycle be traveling the moment the car comes to a stop? (1 mark)

iii) How far apart are the vehicles at t = 20 s? (2 marks)

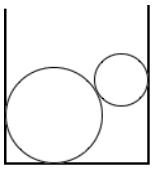
QUESTION 32

a) The diagram shows two trolleys that are able to move in the same straight line on a horizontal surface. Their masses are shown.

If when impact occurs X is moving to the right at 15 m/s and Y is moving to the left at 5 m/s and the trolleys lock together, with what velocity do they move off after the collision? (2 marks)

b) For how long must a force of 120 Newton act on a mass of 50 kg to produce a change in velocity from 1 m/s to 5.5 m/s if there is a force of 20 Newton opposing the motion? (3 marks)

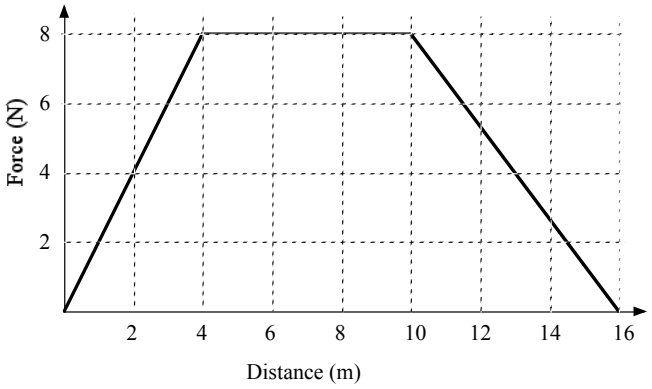
c) A cylindrical tin stands on a smooth table and 2 smooth spheres rest inside the tin as shown. Draw the forces acting on the tin. (2 marks)



QUESTION 33

a) Define the terms work and power. (2 marks)

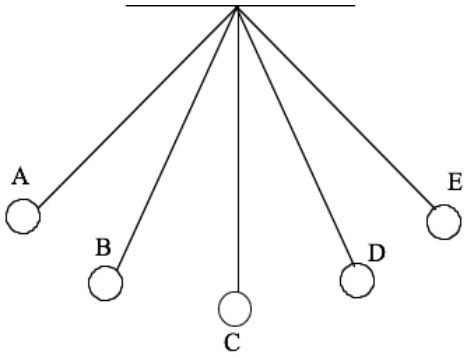
b) The following graph shows how a horizontal force varies with distance as it acts on a mass of 3kg initially at rest. The mass moves in a straight line on a frictionless horizontal surface /floor.



(i) How much work was done by the force in moving the body the first 4m? (1 mark)

(ii) Calculate the velocity of the mass at 4 meters. (3 marks)

c) Shown is a swinging pendulum. At which position A, B, C, D or E does the bob have minimum potential energy and a maximum kinetic energy? (1 mark)



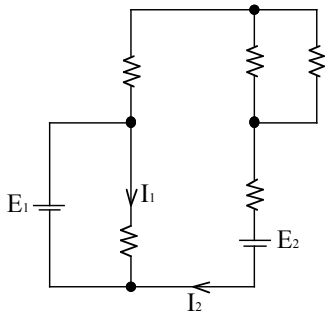
QUESTION 34

A transformer on a power pole operates at a primary voltage of Vp = 8.5 kV and supplies electrical energy to a number of houses at Vs = 120V. Assume the loads are purely resistive. If the average rate of energy consumption in the houses served by the transformer is 78kW.

a) What are the currents in the primary (I_P) and secondary (I_S) sides of the transformer? (2 marks)

b) What are the resistive loads in the primary (R_P) and the secondary (R_S) sides of the transformer? (2 marks)

c) The figure below shows a circuit with two voltages sources E_1 = 12V and E_2 = 4V. The resistors are all 4Ω resistors.



(i) Simplify the circuit labeling resistors with their correct values. (2 marks)

(ii) Calculate the current I_1. (1 mark)

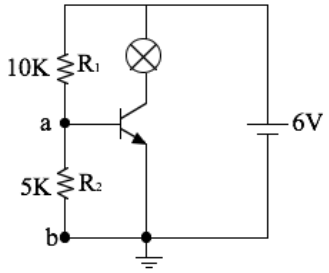
QUESTION 35

a) Perform the following binary number addition. (1 marks)

$$\begin{array}{r} 011 \\ \underline{101}^{+} \end{array}$$

b) What is the purpose of using the diode as a rectifier? (1 mark)

c) In the following circuit;

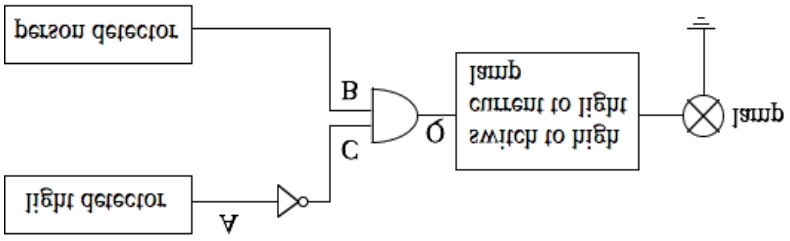


i) What are resistors R_1 & R_2 doing? (1 mark)

ii) Is the lamp on or off? (1 mark)

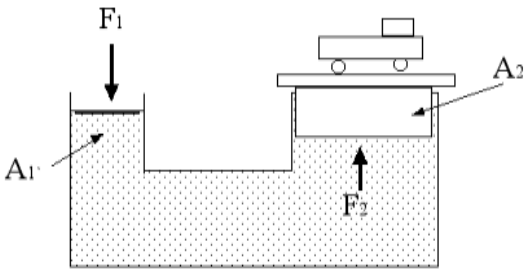
iii) If we remove R_2 and place a wire instead (from a to b), what will be the effect on the lamp? (1 mark)

d) The following circuit (combination of gates), is a security light system. Complete the truth table for it, showing all possible states (combination) for C and D. (2 marks)



QUESTION 36

a) In a car lift, compressed air exerts a force F_1 on a small piston having a radius 5cm. This pressure is transmitted to a second piston of radius 15cm



i) Calculate F_1 if the mass of the car to be lifted is 1350kg. (1 mark)

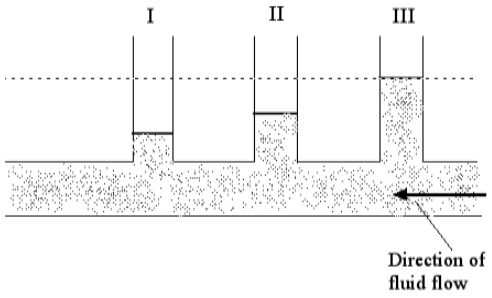
ii) What is the pressure necessary to accomplish this task? (1 mark)

b) A fully loaded aircraft has a mass of 3.3×10^5 kg. Its total wing area is $500m^2$. It is in level flight with a speed of 960km/hr.

i) Calculate the pressure difference between the lower and upper surface of the wings. (1 mark)

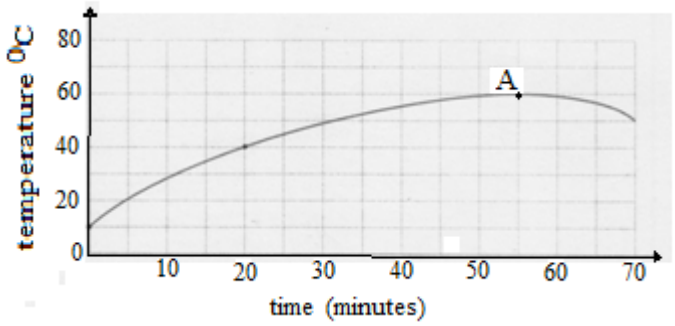
ii) Using Bernoulli's equation $P_1 + \rho g h_1 + \rho \frac{v_1^2}{2} = P_2 + \rho g h_2 + \rho \frac{v_2^2}{2}$ and ignoring the small height difference between the top and bottom sides of the wing, calculate the percentage increase in the speed of the air on the upper surface of the wing relative to the lower surface. (Density of air is 1.2kg/m) (3 marks)

c) Water flows in a pipe. Three identical tubes are fitted into the pipe and depths of water in the three tubes are shown. The dashed line shows the reference pressure line. Explain why there is a drop in pressure in the tubes. (1 mark)



QUESTION 37

The graph below shows temperature versus time for the water in a tank/cylinder after the heater has been switched on. The heater is switched off at point A on the graph.



a) What is the rate at which the temperature of the water in the tank increases over the first 20 minutes? (2 marks)

b) The mass of water in the tank is 40 kg. What is the amount of heat supplied by the heating coil in the first 20 minutes?

(2 marks)

c) If the mass is 40kg, what would be the power of the heater? (2 marks)

d) How could the heat loss from the cylinder be reduced? (1 mark)

QUESTION 38

a) A uniform sinusoidal wave of wavelength 8.71cm travels along a string. The time for a particular point to reach maximum point (or peak) to the immediate zero point is 0.170s.

(i) What is the period of the wave? (1mark)

(ii) What is the speed of the wave? (1mark)

b) State the main differences between a mechanical wave and an electromagnetic wave. (2 marks)

c) A student decides to use an echo sounder to measure the depth of water under a boat. Explain how he would do that. (1 mark)

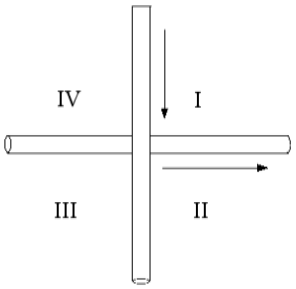
d) Diamond has a refractive index of 2.42. The speed of light in air is $3x10^8$m/s.

(i) Calculate the speed of light in diamond. (1mark)

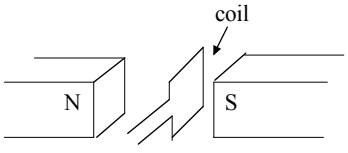
(ii) Calculate the critical angle of diamond. (1mark)

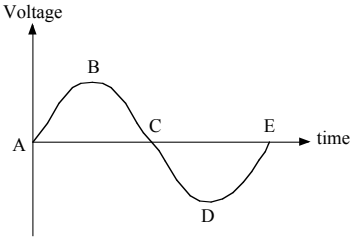
QUESTION 39

a) The diagram below shows two perpendicular wires carrying equal current as shown. The wires are not touching each other. In which quadrant/s (I, II, III, or IV), are there points where the magnetic field is zero? Explain your choice of answer? (2 marks)



b) A voltage is produced in a coil as it rotates inside a magnetic field produced by two magnets. The graph below shows how the voltage produced changes as the coil rotates.

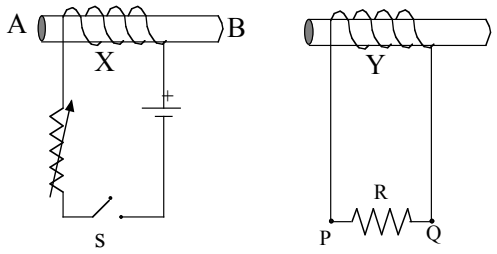




i) How is the coil positioned with regard to the magnetic field when voltage is 0 as indicate by A, C and E? (1 mark)

ii) How is the coil positioned with regard to the magnetic field when the peak voltage is reached as indicated by B and D? (1 mark)

c) When switch **s** in the diagram shown below is closed, coil X becomes a magnet.



i) Which end A or B becomes the North Pole? (1 mark)

ii) A current flows momentarily in coil Y. In which direction do the electrons flow through R? (1 mark)

iii) What will be the direction of the electron flow in coil Y after the switch has been closed for a few seconds? (1 mark)

QUESTION 40

a) State two ways to minimize the effect of radiation on radiation workers. (2 marks)

b) An isotope of uranium decays to form a thorium atom.

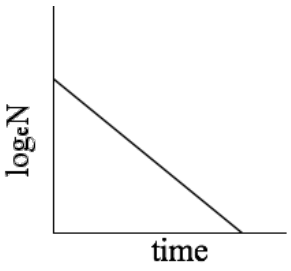
$U_{90}^{238} \rightarrow Th_{88}^{234} +$

i) Complete the above equation. (1 mark)

ii) Name the type of decay that occurs. (1 mark)

iii) Give the number of neutrons present within the nucleus of a U_{90}^{238} atom. (1 mark)

c) The graph below shows the variation of the natural log of the sample size N of a radioactive sample with time.



Explain how you would use the above graph to find

(i) the original sample size N. (1mark)

(ii) the decay constant λ, of the sample. (1 mark)

END OF EXAMINATION

PHYSICS

SECTION B – ANSWER BOOKLET

Write your name, province and school codes and your candidate number correctly and clearly in the spaces provided below.

Year		Province		School			Candidate		
1	3								

Candidate Name: _____

School Name: _____

ANSWERS WRITTEN ON THE QUESTION PAPER OR ANY OTHER PAPER WILL NOT BE MARKED.

WRITE ANSWERS NEATLY IN THE SPACES PROVIDED IN THIS ANSWER BOOKLET

****

FOR MARKERS USE ONLY

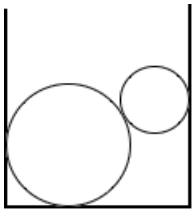
	Score	Markers' Initials	
		Marker 1	Marker 2
SECTION B			
QUESTION 31			
QUESTION 32			
QUESTION 33			
QUESTION 34			
QUESTION 35			
QUESTION 36			
QUESTION 37			
QUESTION 38			
QUESTION 39			
QUESTION 40			
	70		

START YOUR WORK ON THE NEXT PAGE

SECTION B - ANSWERS

Write your answer in the space provided below. Your answers must be clear and precise.

QUESTION 31	Mark/ Quest	Marker 1	Marker 2
(a) i)			
_____	1		
ii)			
_____	1		
(b) i)			
_____	2		
ii)			
_____	1		
iii)			
	2		
For Markers Use Only **Q 31 Total**			

QUESTION 32	Mark/Q	Marker 1	Marker 2
a) _____	2		
b) _____	3		
c) 	2		
For Markers Use Only **Q 32 Total**			

QUESTION 33	Mark/Q	Marker 1	Marker 2
a) Work _____	1		
_____			
Power _____	1		
_____			
b) i.			
_____	1		
ii.			
_____	3		
c) _____	1		
For Markers Use Only **Q 33 Total**			

QUESTION 34	Mark/Q	Marker 1	Marker 2
a)			
I_P _____	1		
I_S _____	1		
b)			
R_P _____	1		
R_S _____	1		
c) i)			
_____	2		
ii)			
_____	1		
For Markers Use Only **Q 34 Total**			

QUESTION 35	Mark/Q	Marker 1	Marker 2
a) _____	1		
b) _____	1		
c) i) _____	1		
ii) _____	1		
iii) _____	1		
d) Truth Table A B C Q 0 0 0 1 1 0 1 1	2		
For Markers Use Only **Q 35 Total**			

QUESTION 36	Mark/Q	Marker 1	Marker 2
a) i)			
_____	1		
ii)			
_____	1		
b) i)			
_____	1		
ii)			
_____	3		
c) _____	1		
For Markers Use Only **Q 36 Total**			

QUESTION 37	Mark/Q	Marker 1	Marker 2
a)			
_____	2		
b)			
_____	2		
c)			
_____	2		
d) _____	1		
For Markers Use Only **Q 37 Total**			

QUESTION 38	Mark/Q	Marker 1	Marker 2
a) i)			
_____	1		
ii)			
_____	1		
b) _____			
_____	2		
_____			
c) _____			
_____	1		
_____			
d) i)			
_____	1		
ii)			
_____	1		
For Markers Use Only **Q 38 Total**			

QUESTION 39	Mark/Q	Marker 1	Marker 2
a) _____ _____	2		
b) i) _____ ii) _____ _____	1 1		
c) i) _____ ii) _____ iii) _____	1 1 1		
For Markers Use Only **Q 39 Total**			

QUESTION 40	Mark/Q	Marker 1	Marker 2
a) i) _____	1		
ii) _____	1		
b) i) $U_{90}^{238} \rightarrow Th_{88}^{234} +$ _____	1		
ii) _____	1		
iii) _____	1		
c) i) _____	1		
ii) _____	1		
For Markers Use Only **Q 40 Total**			

HIGHER SCHOOL CERTIFICATE EXAMINATIONS

PHYSICS DATA SHEET

CONSTANTS		
Acceleration due to gravity (g) = 10 m s^{-2} = 10 N kg^{-1} c = 3·0 x 10^8 m s^{-1} , $\mu_o = 4\pi \times 10^{-7}$ Decay constant (") = 0.63 ÷ half-life in seconds		
FORMULAE		
$P = \frac{F}{A}$	$P = hDg$	$D = \frac{m}{V}$
$v_{av} = \frac{s}{t}$	$a = \frac{v - u}{t}$	$v^2 = u^2 + 2as$
$s = ut + \frac{1}{2}at^2$	$F = ma$	$W = Fs$
$E_p = mgh$	$E_k = \frac{1}{2}mv^2$	$P = \frac{W}{t}$
$v = f\lambda$	$T = \frac{1}{f}$	$n = \frac{\sin \hat{i}}{\sin \hat{r}}$
$n = \frac{1}{\sin \hat{c}}$	$E = mc^2$	$V = IR$
$P = IV$	$E = IVt$	$R = R_1 + R_2 + \ldots.$
$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots.$	$Q = It$	$V = \frac{E}{Q}$
$V_s I_s = V_p I_p$	$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	$Q = mc\Delta T$
$Q = mL$	$p = mv$	
Efficiency = $\frac{\text{work output}}{\text{work input}} \times 100$		

Unless otherwise stated, the direction of current in electric circuits must be treated from positive terminal to negative terminal (conventional direction of current)