



DEPARTMENT OF  
EDUCATION

UPPER SECONDARY  
SCHOOL CERTIFICATE  
EXAMINATIONS

**PHYSICS**

Wednesday

15 October 2014

Time allowed:

2 hours and 30 minutes

(8:00am – 10:30 am)

NO EXTRA TIME

(NO OTHER TIME)

Candidates are advised to fully  
utilize the allocated time

**P**

## INSTRUCTIONS TO CANDIDATES

*To be read by the external invigilator to all candidates*

1. The subject code for 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 Part A Electronic Answer Sheet. They are inserted in the middle of your Question Booklet.

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 Part **MUST** be answered on the ELECTRONIC ANSWER SHEET provided.

4. 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 your 10-digit candidate number on the Part B Answer Sheet provided.

5. You are required to 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.
10. 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.
11. Graphical Calculators are not permitted.
12. Enough spaces have been allocated for answers to every question. Questions must be answered in spaces as allocated. Answers all over the answer booklet may not be marked.

**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.**

**PART 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 or B or C or D. If you make a mistake, rub it out completely using an eraser rubber and shade the correct answer on the ELECTRONIC ANSWER SHEET.

**QUESTION 1**

Which of the following is **not** a force?

- A. Tension in a string.
- B. Weight of an object.
- C. Drag experienced by a falling body in air.
- D. Electrical current in a circuit.
- E. Weight of displaced water.

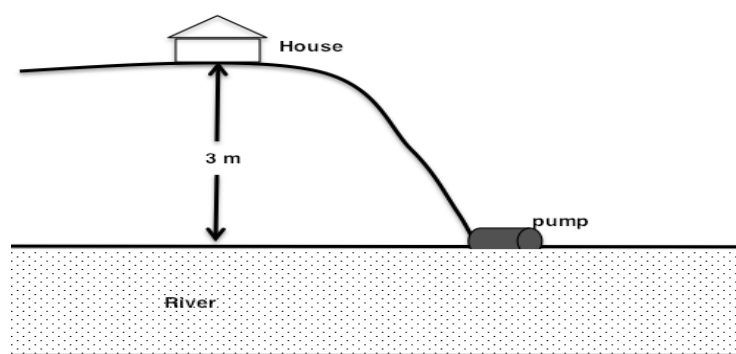
**QUESTION 2**

When two identical waves having amplitude  $A$  and phase angle of zero interfere constructively, what is the amplitude of the resulting wave?

- A.  $A/3$
- B.  $A/4$
- C. Zero
- D.  $2A$
- E.  $A/2$

**QUESTION 3**

Water is pumped up from a river to a house whose elevation is 3m above the river. Water is delivered at a rate of three kilograms per second.



The power of the pump is:

- A. 3 watts
- B. 30 watts
- C. 90 watts
- D. 60 watts
- E. 6 watts

**QUESTION 4**

The atomic number of an element is the number of \_\_\_\_\_.

- A. protons
- B. neutrons
- C. electrons
- D. alpha particles
- E. beta particles.

**QUESTION 5**

What is the appropriate S.I. Unit for measuring temperature?

- A. candela      B.  $^{\circ}F$       C. kelvin      D.  $^{\circ}C$       E. ampere

**QUESTION 6**

Suppose you place an object made of wood on a scale and read its weight. You now suspend/immense that objects in a container with water and check its weight, while inside the water.

How the scale reading supposes to change?

- A. Increase  
B. Decrease  
C. Should remain the same as, when outside the water.  
D. Keep changing without getting a stable reading.  
E. The needle on the scale should go out of the scale.

**QUESTION 7**

Which of the following techniques/methods will **not** result in a maximum induced voltage?

- A. Faster relative movement of a magnet to a coil.  
B. Relative fast movement of a coil respect to a magnet.  
C. By adding more turns to a coil.  
D. Using a stronger magnet.  
E. Both coil and magnet moving at the same speed.

**QUESTION 8**

Considering a transistor as a device composed of 2 diodes (PN junctions); suppose you found out that the Base-emitter junction is forward biased and the collector-base junction is reverse biased, therefore the transistor condition is more likely to be:

- A. Transistor is in cut-off mode  
B. Transistor is in saturation mode of operation  
C. Transistor is operating in active mode  
D. Transistor is operating as an open switch  
E. Transistor is operating as a closed switch

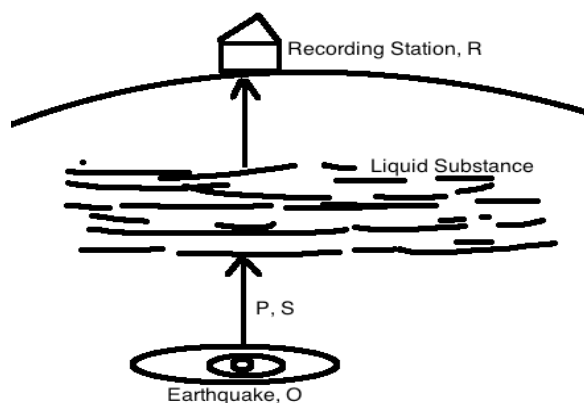
**QUESTION 9**

Which of the following statements describe the Wheatstone bridge?

- A. The Wheatstone bridge is used to measure very small resistance values.
- B. Most Wheatstone bridges are accurate to approximately 1 percent.
- C. Resistance values obtained from using ohmmeters or voltmeter-ammeter method are more accurate than values obtained by the Wheatstone bridge.
- D. Commercial Wheatstone bridges are accurate to approximately 0.1 percent.
- E. Commercial Wheatstone bridges are accurate only on the range from  $1\Omega$  to  $10\Omega$ .

**QUESTION 10**

In an earthquake (O) of a large magnitude, both the Primary waves (P) and Secondary waves (S) are generated which may be recorded at station R at the surface of the earth. P waves are longitudinal waves while S waves are transverse in nature.



If a liquid substance lies along the path of the waves, what can you say about the detection of the waves by station R?

- A. R may record only S waves
- B. R may record only P waves
- C. R may record P and then S waves in that order.
- D. R may record S and then P waves in that order
- E. R may record both P and S waves at the same time

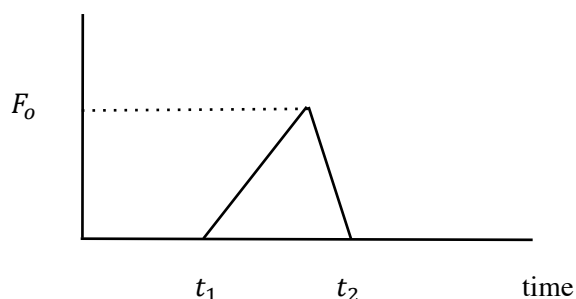
**QUESTION 11**

A 500 grams ball is thrown vertically upwards with a speed of 20 m/s. What is the kinetic energy of the ball at the height of 5 m ?

- A. 25
- B. 30
- C. 40
- D. 75
- E. 50

**QUESTION 12**

The graph below shows how a force exerted on an object varies with time.  $F_0$  is the maximum force,  $t_1$  and  $t_2$  are times.



The change in momentum of the object is

- A.  $F_0(t_2 - t_1)$     B.  $(t_2 - t_1)/F_0$     C.  $F_0(t_2 - t_1)/2$     D.  $(t_2 - t_1)/(2F_0)$     E.  $2F_0(t_2 - t_1)$

**QUESTION 13**

A radioactive isotope decays by emission of an alpha particle. What can be said about the atomic number of the isotope?

- A. remains constant    B. decreases by two    C. increases by two  
D. decreases by four    E. increases by four

**QUESTION 14**

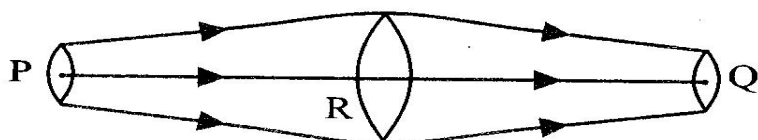
A child of mass  $10 \pm 0.03$  kg is sleeping in a bilum hanging  $2 \pm 0.005$  m above the ground.

What is the percentage error in the potential energy of the child? Take  $g = 10 \pm 0.01$  m/s<sup>2</sup>.

- A. 4.5 %    B. 0.65 %    C.  $7.5 \times 10^{-7}$ %    D. 0.0225%    E. 0.3 %

**QUESTION 15**

Suppose we have an horizontal pipe with the following shape with fluid flowing from P and Q, which of the statements is correct?



- A. The fluid is decelerated while passing from R to Q.  
B. The fluid is accelerated while passing from R to Q.  
C. The fluid's velocity does not change when passing from R to Q.  
D. There is no change in pressure in the fluid from P to Q.  
E. Pressure will be zero when passing from P to Q.

**QUESTION 16**

Which of the following statements best describe a power transformer?

- A. Is a device that produces electrical energy from one circuit to another through the transformer's coils.
- B. Is the device that transfers electrical energy from one circuit to another through inductively coupled conductors called the transformer's coils.
- C. Is a device that converts electrical energy from one circuit to mechanical energy in another one through the transformer's coil.
- D. Is a device that produces electrical energy and transfers it to another one as light through the transformer's coils.
- E. Is a device that may be able to transform light energy from one circuit to another through the coils.

**QUESTION 17**

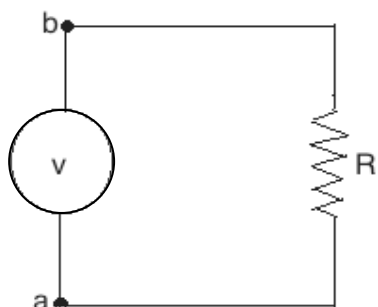
A vehicle travels at 100km/hr on a straight road, suddenly a pig crosses that road and the vehicle slows down to 80km/hr after 1 hour.

What is the acceleration?

- A.  $-20 \text{ km/hr}^2$
- B.  $180 \text{ km/hr}^2$
- C.  $-20 \text{ km/hr}$
- D.  $-50 \text{ m/min}^2$
- E.  $20 \text{ m/s}^2$

**QUESTION 18**

If you have a resistive circuit like the one in the following figure and assuming that the AC generator gives you  $V_{ab} = V_n \cos \omega t$  where  $V_n$  is the amplitude of the applied voltage and  $\omega = 2\pi f$ .

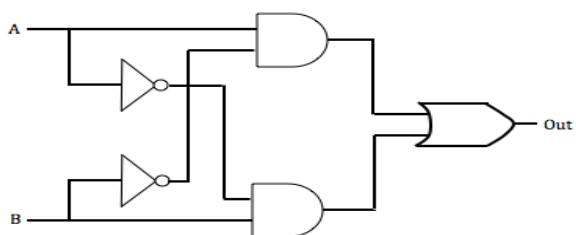


If you increase the driving frequency  $f$  of the generator, the current amplitude will

- A. Increase
- B. Remain the same
- C. Decrease
- D. Go to zero from high values of frequency  $f$
- E. double

**QUESTION 19**

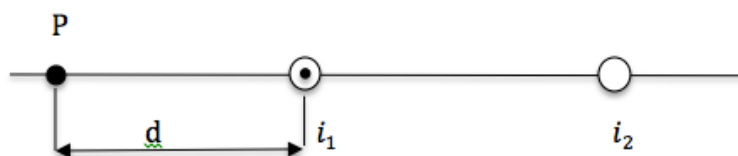
The following circuit behaves like one of the basic gates, identify it.



- A. OR
- B. AND
- C. EXOR
- D. NOR
- E. NAND

**QUESTION 20**

The following figure shows cross sections of two long straight wires, where the left-hand wire carries current  $i_1$  directly out of the page.



If the net magnetic field due to the 2 currents  $i_1$  and  $i_2$  (on the right-hand wire), is to be zero at point P, current  $i_2$  should be:

- A. less than  $i_1$ .
- B. greater than  $i_1$  and into the page.
- C. equal to  $i_1$  in magnitude and direction.
- D. zero.
- E. greater than  $i_1$  and out of the page.

**QUESTION 21**

Which of the following statements is the most accurate in relation to the Bernoulli's principle?

- A. Fast moving air causes lower pressure.
- B. Lower pressure is caused by slow-moving fluid.
- C. Both statements above : A and B are equally accurate.
- D. According to Bernoulli, as we move in a moving/flowing fluid, the sum of kinetic and potential energy per unit volume does not remain constant.
- E. As we move in a moving fluid, the sum of pressure plus kinetic energy per unit volume does not remain constant.

**QUESTION 22**

Two identical ice cubes are investigated on their rate of melting. Both ice cubes are placed in a plate and one covered by a black sheet of paper while the other is covered by a white sheet of paper.

Which statement best describes the results?

- A. Ice cube covered by white paper would melt faster than the one covered by a black sheet of paper.
- B. Ice cube covered by black paper would melt faster than the one covered by the white sheet of paper.
- C. Ice cube covered by black sheet of paper would melt slower than the one covered by the white sheet of paper.
- D. Both ice cubes will melt at the same rate.
- E. There will be no changes in the size of both cubes.

**QUESTION 23**

A body of mass  $m$  experiences a force  $F$  resulting in an acceleration  $a$ . When the force is doubled, the acceleration of the body will be:

- A. doubled.    B. halved.    C. tripled.    D. reduced by  $1/3$ .    E. increase three times.

**QUESTION 24**

Which of the following statements better describe something about the process of charging an object by another object?

- A. When we rub an object against another one, charge is created so we can charge positively or negatively an object this way.  
 B. During this rubbing process we create negative charges on the rubbing object so it gets charged negatively.  
 C. In this rubbing process, the electrified state of the object is due to a transfer of charge from one object to the other.  
 D. Since this is a process of creation of charge, we can conclude/say that charge is not conserved.  
 E. Rubbing an object to charge another object will deplete the first object of charges so it will end up uncharged.

**QUESTION 25**

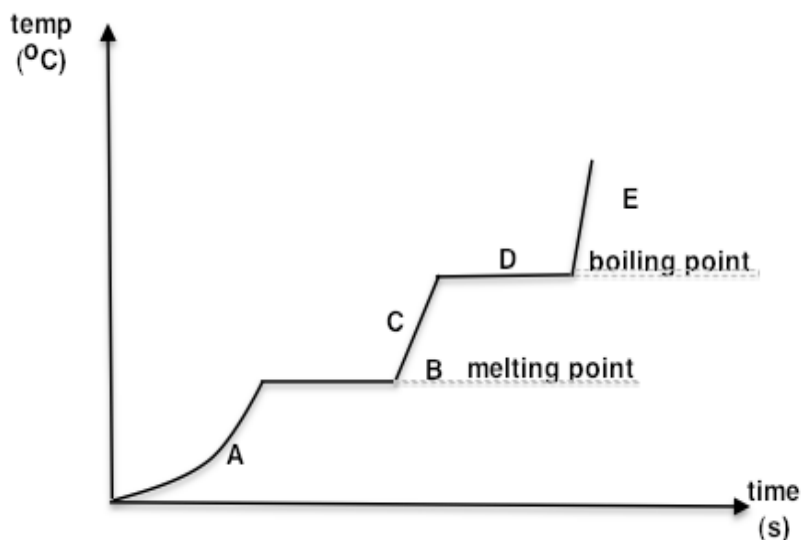
A coconut falls from a 12 m tree.

What would be its velocity half-way down?

- A. 10 m/s                      B. 11 m/s                      C. 12 m/s                      D. 24 m/s                      E. 21 m/s

**QUESTION 26**

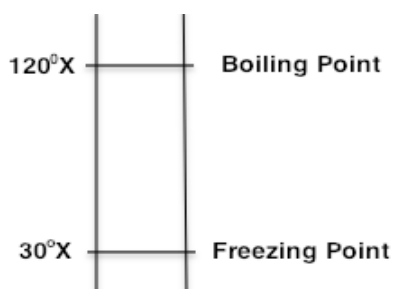
The graph shows temperature of a pure substance changes as it is heated. At what stage on the graph would the latent heat formula be used?





**QUESTION 27**

Given a temperature scale with the freezing and boiling point of water as indicated below.



What would be  $200^{\circ}\text{C}$  in this temperature scale?

- A.  $200^{\circ}\text{X}$     B.  $90^{\circ}\text{X}$     C.  $189^{\circ}\text{X}$     D.  $50^{\circ}\text{X}$     E.  $47^{\circ}\text{X}$

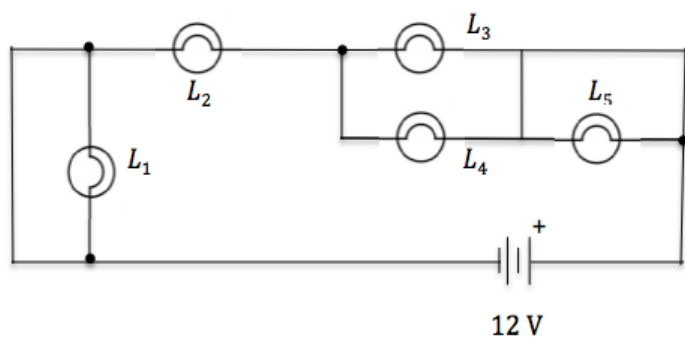
**QUESTION 28**

When light travels in a material with refractive index of  $4/3$ , the speed of the light in the material is

- A.  $3.00 \times 10^8 \text{ m/s}$     B.  $2.25 \times 10^8 \text{ m/s}$     C.  $1.33 \times 10^8 \text{ m/s}$   
 D.  $3.33 \times 10^7 \text{ m/s}$     E.  $2.25 \times 10^7 \text{ m/s}$

**QUESTION 29**

Assuming that in the following circuit all the lamps are identical, which of the lamps will be the brightest?



- A. L3    B. L2    C. L1    D. L5    E. L4

**QUESTION 30**

A soccer ball is kicked and it takes off at an angle of  $30^{\circ}$  and an initial speed of  $20 \text{ m/s}$ . What is the time for the ball to reach its maximum height?

- A. 2 seconds    B. 1 second    C. 1.7 seconds    D. 10 seconds    E. 17 seconds

**PART B: SHORT ANSWERS**

**(QUESTIONS 31 to 40)**

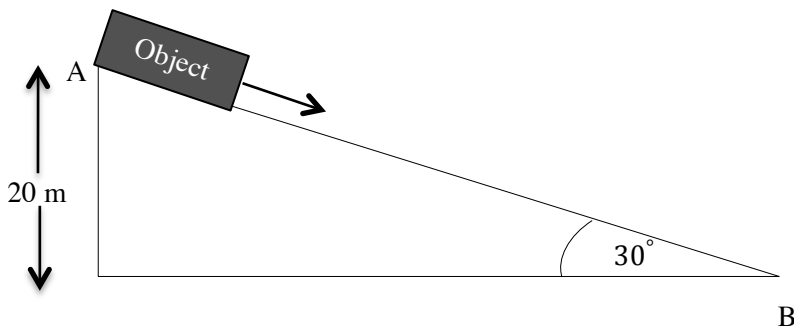
For each Question, work out the answer and write it in the space provided on the ANSWER BOOKLET.

**QUESTION 31**

- a). Explain the nuclear processes of fission and fusion ( 2 marks)
- b). Explain the use of the following components of a nuclear reactor
- i. moderator (1 mark)
  - ii. fuel rod (1 mark)
  - iii. control rod (1 mark)
- (c). A large electric generating station is powered by a pressurized-water nuclear reactor. The thermal power produced in the reactor core is 3400 MW, and 1100 MW of electricity is generated by the station.
- What is the station's efficiency? (2 marks)

**QUESTION 32**

An object moves along a smooth inclined plane as shown in the diagram, with an initial velocity of 10 m/s and accelerates at  $2 \text{ m/s}^2$ .



- a). Calculate the distance the object moved from point A to point B. ( 2 marks)
- b). What would be its velocity at point B? ( 3 marks)
- c). What would be the average time for the object to move from point A to point B? (2 marks)

**QUESTION 33**

a) Explain what a transverse wave is.

( 1mark )

b). Two graphs relating to wave motion are shown below.

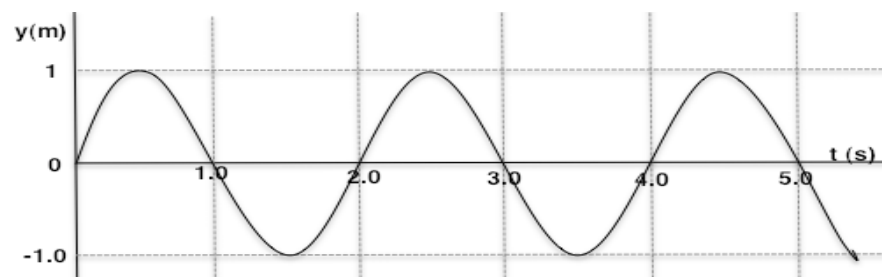


Fig 1. Motion of a particle as a function of time.

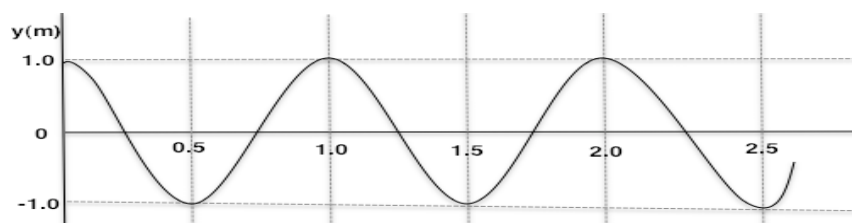


Fig 2. Snapshot of the waves showing positions of particles as the wave passes along the medium.

Use the two graphs above to answer the following questions.

- i). What is the amplitude of the wave? ( 1 mark)
- ii). What is the period of the wave? (1 mark)
- iii). What is the frequency of the wave? (1 mark)
- iv). What is the wavelength of the wave? (1 mark)
- v). What is the speed of the wave? (2 marks)

**QUESTION 34**

You are asked to calculate the average volume coefficient of the ‘mumu’ stones. Outline logically and clearly the procedure/methods, you are given or provided the following:

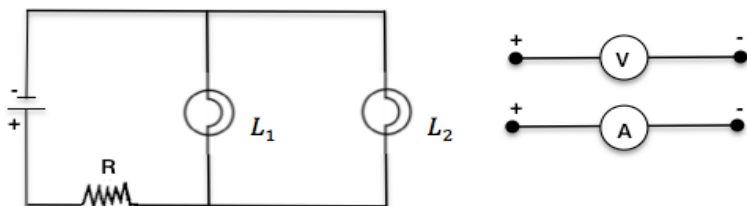
10 mumu stones, firewood, thongs, thermometer, measuring cylinder, packet and a pot.

Given  $\Delta V = \beta V_0 DT$ , where  $\beta$  = specific volume expansion coefficient and  $V_0$  = initial average volume of 10 stones

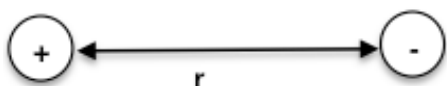
( 7 marks)

**QUESTION 35**

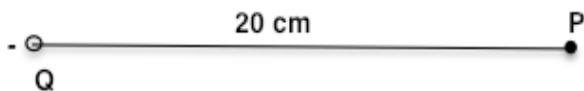
a). Suppose you are given the following circuit where the 2 lamps are similar and operated from one battery. You are asked **to redraw the circuit** to include all of the following.



- i). A switch which will switch ON and OFF only one of the lamps. (1 mark)
  - ii). An ammeter to measure the total current taken by the battery. (1 mark)
  - iii). If a short circuit develops in the above circuit which causes both lamps to “blow”, where is it most likely to have occurred? (1 mark)
- b). Draw the electric field lines for the following pair of charges interacting. (1 mark)



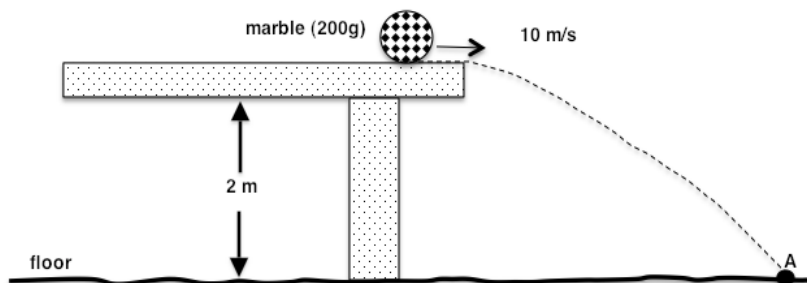
c) Calculate the **magnitude and direction** of the electric field at a point P which is 20 cm from a point charge of magnitude  $Q = -2.0 \times 10^{-6} C$ . (2 marks)



d). Is the 240 volts provided by PNG Power, a peak value? Or an rms (root mean square) value for the voltage? (1 mark)

**QUESTION 36**

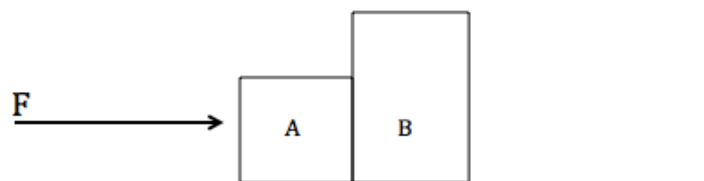
A 200 grams marble is projected horizontally over the edge of the table that is 2 m above the floor with a velocity of 10 m/s as shown in the diagram below. The marble lands at point A on the floor.



- a). Calculate the speed of the marble at the instant it lands at A. ( 4 marks)
- b). Calculate the work done by the gravitational force on the marble after it leaves the table and lands at A. (3 marks)

**QUESTION 37**

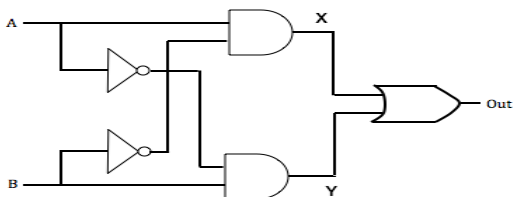
Two blocks A and B are in contact close and are at rest on a smooth surface. Block A has a mass of 1.0 kg and block B has a mass of 3.0 kg. A force F of magnitude 12 N is applied horizontally on block A. The diagram below shows the situation.



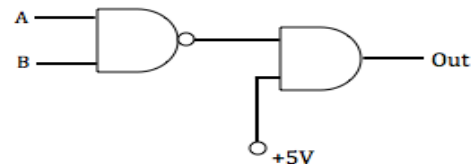
- a). Calculate the **common** acceleration of the two blocks. ( 3 marks)
- b). Calculate the force exerted by block A on block B. ( 3 marks)
- c). What is the force exerted by block B on block A? (1 mark)

**QUESTION 38**

- a). Obtain the truth table of the following circuit. (2 marks)



- b). The following digital circuit behaves like an \_\_\_\_\_ gate. (1 mark)



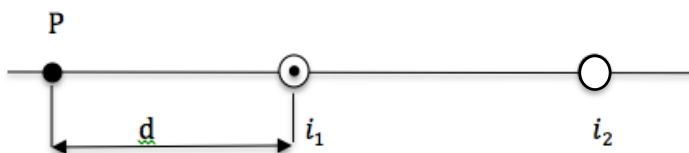
- c). Is a diode built with intrinsic semiconductor material or with extrinsic semi conductor material? (1 mark)
- d). What is the main difference between intrinsic semiconductor and extrinsic semiconductor materials? (1 mark)
- e). When do we say that a diode is in a reverse bias condition? (1 mark)
- f). We can consider a transistor as 2 PN junctions isn't? ( or we can say, 2 diodes (base-emitter diode and collector-base diode). Based on this, when can we say that a transistor is working? ( Bias conditions for those two diodes). (1 mark)

**QUESTION 39**

- a) Determine the mass and weight of the air in a living room at  $20^{\circ}\text{C}$  with a  $4.0\text{ m} \times 5.0\text{ m}$  floor and a ceiling  $3.0\text{ m}$  high. (take density of air as  $1.2\text{kgm}^{-3}$ ). (1 mark)
- b) What would be the total downward force on the surface of the floor due to the air pressure of  $1.0$  atmosphere in the question a) above? (1 mark)
- c) Suppose you are floating in a canoe and fishing in a lake (in the middle of the lake) and suddenly catch a  $12\text{kg}$  fish and load it onto the canoe. Does the water level in the lake rise or fall after loading the fish in your canoe? Explain. (2 marks)
- d) Suppose you have a garden hose of diameter  $2\text{ cm}$  and you use it to fill a  $25$  liters bucket/container. Suppose it takes you  $1$  minute to do that.
- Calculate the speed at which the water enters the bucket. (1 mark)
  - Suppose the open end of the hose is then squeezed to a diameter of  $5\text{ mm}$ . What is speed at which water comes out of the hose? (1 mark)
- e). Give a reason why surface tension concept does not apply to gases but only to liquids. (1 mark)

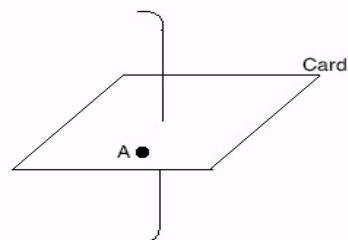
**QUESTION 40**

- a). The following figure shows cross sections of two long straight wires, the left hand wire carries current  $i_1$ , directly out of page.



- If the magnetic field at point P due to the currents  $i_1$  and  $i_2$  where  $i_2$  is the current carried by the right hand wire is to be zero; what should be the direction of the current  $i_2$  in the right hand wire be? (1 mark)

- b). Suppose that the vertical wire in the following figure is at right angle ( $90^{\circ}$ ) to the card (horizontal surface), in what direction will a compass at position A (in front of the wire) points when:



- there is no current through the wire? (1 mark)
- current flows downwards? (1 mark)

- c). Suppose a transformer has a turns ration of  $1/3$ . The input coil is connected to a 15 V AC supply. Assuming there are no energy or field line losses
- i). what is the output voltage (1 mark)
- ii). What turns ratio would be required to obtain output voltage of 45 volts? (1 mark)
- d). Suppose a wire of length 10 m and mass 50 grams is suspended in air in a region with magnetic field of 0.50 Tesla at right angle to the wire. Calculate the current that would have to flow through the wire to just prevent it from falling to the ground. (2 marks)

**END OF EXAMINATION**

# PHYSICS - 2014

## PART B – Answer Booklet

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

Year	Province	School	Candidate No
------	----------	--------	--------------

Year	Province	School	Candidate No
1	4		

Candidate Name: \_\_\_\_\_

School Name: \_\_\_\_\_

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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

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### FOR MARKERS USE ONLY

	Score	Markers' Initials	
		Marker 1	Marker 2
<b>PART B</b>			
QUESTION 31			
QUESTION 32			
QUESTION 33			
QUESTION 34			
QUESTION 35			
QUESTION 36			
QUESTION 37			
QUESTION 38			
QUESTION 39			
QUESTION 40			
<b>FINAL TOTAL</b>	<b>70</b>		



## SECTION B – ANSWERS


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

QUESTION 31	Mark/Q	Marker 1	Marker 2
a). _____ _____	2		
	1		
b). i. moderator _____ _____	1		
	1		
ii. fuel rod. _____ _____	1		
iii. control rod. _____ _____			
c). _____ _____			
	2		
For Markers Use Only	<b>Q 31 Total</b>		

QUESTION 32	Mark/Q	Marker 1	Marker 2
(a).			
(b).	2		
(c).	3		
For Markers Use Only	2		
<b>Q 32 Total</b>			

QUESTION 33	Mark/Q	Marker 1	Marker 2
(a). Transverse Wave. _____ _____	1		
(b). i.  _____	1		
ii.  _____	1		
iii.  _____	1		
iv.  _____	1		
v.  _____	2		
For Markers Use Only	<b>Q 33 Total</b>		

QUESTION 34	Mark/Q	Marker 1	Marker 2
	7		
For Markers Use Only	<b>Q 34 Total</b>		

QUESTION 35	Mark/Q	Marker 1	Marker 2
(a) i.	1		
ii.	1		
iii. _____	1		
(b) 	1		
(c)	2		
(d)	1		
For Markers Use Only	<b>Q 35 Total</b>		

QUESTION 36	Mark/Q	Marker 1	Marker 2
(a).			
(b).	4		
	3		
<b>For Markers Use Only</b>	<b>Q 36 Total</b>		

QUESTION 37	Mark/Q	Marker 1	Marker 2
(a).			
(b).	3		
(c)	3		
(c)	1		
For Markers Use Only	<b>Q 37 Total</b>		

QUESTION 38	Mark/Q	Marker 1	Marker 2
<p>(a).</p>           <p>(b). _____</p> <p>(c). _____</p> <p>(d). _____                      _____                      _____</p> <p>(e). _____</p> <p>(f). _____</p>	<p>2</p>           <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>		
For Markers Use Only	<b>Q 38 Total</b>		



QUESTION 39	Mark/Q	Marker 1	Marker 2
(a). _____  	1		
(b). _____  	1		
(c). _____ _____ _____	2		
(d). i. _____  	1		
ii. _____  	1		
(e). _____ _____	1		
For Markers Use Only	<b>Q 39 Total</b>		

QUESTION 40	Mark/Q	Marker 1	Marker 2
(a). _____	1		
(b). i. _____	1		
ii. _____	1		
(c). i.			
ii. _____	1		
ii. _____	1		
(d).			
_____	2		
For Markers Use Only	<b>Q 40 Total</b>		

HIGHER SCHOOL CERTIFICATION EXAMINATION

PHYSICS DATA SHEET

CONSTANTS			
Acceleration due to gravity (g) = 10ms <sup>-2</sup> = 10N kg <sup>-1</sup> c = 3.0 × 10 ms <sup>-1</sup> , μ <sub>0</sub> = 4π × 10 <sup>-7</sup> Decay constant (λ) = 0.63 ÷ half-life in seconds			
FORMULA			
$P = \frac{F}{A}$	$P = hDg$	$D = \frac{m}{v}$	$v_{av} = \frac{s}{t}$
$a = \frac{v - u}{t}$	$v^2 = u^2 + 2as$	$s = ut + \frac{1}{2}at^2$	$F = ma$
$W = Fs$	$E_p = mgh$	$E_k = \frac{1}{2}mv^2$	$P = \frac{W}{t}$
$v = f\lambda$	$T = \frac{1}{f}$	$n = \frac{\sin \hat{i}}{\sin \hat{r}}$	$n = \frac{1}{\sin \hat{c}}$
$E = mc^2$	$V = IR$	$P = IV$	$E = IVt$
$R = R_1 + R_2 \dots$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$Q = It$	$v = \frac{E}{Q}$
$V_s I_s = V_p I_p$	$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	$Q = mc\Delta T$	$Q = mL$
$p = mv$	$F = \frac{kQ_1 Q_2}{d^2}$	$F = BIl \sin \theta$	$F = nBil \sin \theta$
$F_1 = B_2 I_1 l = I_1 l_2$	$F_1 = B_1 I_2 l = I_2 l_1$	$F_2 = B_1 I_2 l = \frac{\mu I_1 I_2 l}{2\pi}$	$\Delta L = \alpha L_0 DT$
$\Delta L = \beta V_0 DT$	$T_c = T - 273.15^\circ$	$T_f = \frac{9}{5} T_c + 32^\circ$	$B_p = \frac{\mu_0 i}{2\pi d}$
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).