TONGA GOVERNMENT
MINISTRY OF EDUCATION AND TRAINING

TONGA FORM SIX CERTIFICATE
2015
PHYSICS

QUESTION AND ANSWER BOOKLET

Time allowed: 3 Hours

INSTRUCTIONS
1. In addition to this Question and Answer Booklet, you should also be issued with a PHYSICS EQUATIONS SHEET (No.1/15).

2. Write your Student Personal Identification Number (SPIN) in the space provided on the top right hand corner of this page.

3. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.

4. If you need more space for answers, ask the Supervisor for extra paper. Write your SPIN on all extra sheets used and clearly number the questions. Attach the extra sheets at the appropriate places in this booklet.

5. This Examination paper contains TWO sections.

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TIME (MINS)</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>SECTION A : Short Answers</td>
<td>144</td>
<td>80</td>
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<tr>
<td>SECTION B : Multiple Choice</td>
<td>36</td>
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Check that this booklet contains pages 2-27 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

TOTAL MARKS 100
QUESTION 1

a) A 5 cm high object is placed 30 cm in front of a concave mirror whose focal length is 20 cm.

i) Calculate the distance of the image from the mirror.

ii) State whether the image formed is real or virtual.

iii) Calculate the height of the image.
iv) A ray of light in air strikes the surface of water as in the diagram below.

Calculate the angle of refraction in the above diagram.

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v) State the change in the speed of light as it travels from water into air.

_________________________________________________________________

vi) A virtual image is formed 20 cm from a convex lens whose focal length is 20 cm. On the axis below, construct a complete ray diagram showing the correct orientation of the object and the image formed.
b) A wave whose wavelength in shallow water is 0.65 m was observed by a student to travel at a speed of 1.1 ms\(^{-1}\). When it enters the deep region, its speed was reduced to 0.70 ms\(^{-1}\).

i) Calculate the wavelength in the deep region and state whether it is shorter or longer than the wavelength in the shallow region.

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3 marks

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C) A portion of white light was shone on a triangular glass prism and a spectrum of colours labelled A to B was observed on a screen as shown below.

Explain the cause of the spectrum seen on the screen.

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3 marks

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d) Two pulses, 1 and 2 approach each other as shown below.

Draw the **resultant shape** when part A of both pulse superimpose.
e) The following diagram shows the set-up of the double slit experiment done by Thomas Young to estimate the wavelength of blue laser light.

\[ \begin{align*}
\text{blue laser light} & \rightarrow \text{slit (S)} \\
\text{9.0 mm} & \rightarrow \text{screen} \\
0.2 \text{ mm} & \rightarrow \text{slit (S)} \\
3 \text{ m} & \rightarrow \text{source (S)}
\end{align*} \]

i) Calculate the wavelength of the blue laser light used in the above arrangement.

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ii) Identify the type of interference that occurs at point X in the above diagram.

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QUESTION 2

a) Below is a velocity time graph of two motorcycles A and B.

i) What is the total distance travelled by motorcycle B?

ii) Draw the corresponding acceleration-time graph of motorcycle A.
b) A boy dropped two rocks of different masses from the top of a bridge 25 m above the sea surface.

i) Ignoring the effect of air resistance, if these two rocks were released from the same height at the same time, comment on the time these two rocks take to hit the sea surface. Justify your answer.

ii) Using acceleration due to gravity \( g = 10 \, \text{ms}^{-2} \), calculate the speed of the heavier rock at the surface of the sea.

c) An athlete throws a javelin in a competition as shown below.

Resolve this velocity vector into two components:

i) Vertical-Component
ii) Horizontal-Component

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d) Describe in your own words Newton’s 1st Law of motion.

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2 marks
2
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e) Three forces acted on an object as shown below.

i) Calculate the **resultant force** on the object.

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2 marks
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ii) Calculate the **acceleration** of the object.

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1 mark
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NR
f) Two pivots support a 2 m long uniform beam of weight 160 N as shown below.

A man of mass 70 kg stands 0.80 m from pivot A and the beam does not break. Using the two conditions for equilibrium, calculate the upward force $F_A$ from pivot A and $F_B$ from pivot B.
QUESTION 3  

20 marks

a) Two small carts approach each other as shown below.

\[ \begin{array}{c}
\text{5 kg} & \text{5 ms}^{-1} \quad \text{9 ms}^{-1} & \text{6 kg} \\
\end{array} \]

i) Calculate the size of the common velocity if the carts stick together and move after collision.

____________________________________________________________________________________

ii) Calculate the size of the change in momentum of the 5kg cart.

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b) A student placed 2.5 kg rock on a tree branch 3.0 m above the ground. What is the weight force of the rock? (Use \( g = 9.80 \text{ ms}^{-1} \))

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c) A college student kicked a rugby ball right in front of a goal post to win a game as shown in the diagram below. The ball went straight and passed to the other side of the goal post.

![Diagram of rugby kick]

i) Calculate the initial vertical velocity of the ball.

ii) Ignoring air resistance, prove that the ball went 0.79 m below the cross-bar so his team lost the game.
d) A student tied a 0.8 kg mass to a 2.0 m long cotton thread of negligible mass and whirled it so that it undergoes circular motion of period 1.25 seconds as shown below.

i) Calculate the size of the centripetal acceleration of the mass.

ii) Determine the size of the centripetal force on the mass.
e) A coaster car of mass 500 kg ran down a slope as shown below.

i) Calculate the kinetic energy of the cart at section A.

ii) What is the speed of the car at section B?

iii) What is the height above the ground when the speed of the car is exactly 32 ms$^{-1}$?
f) The graph below shows the extension of a spring when different masses are hung from the lower end.

![Force vs Extension graph](image)

Calculate the elastic potential energy of the spring when it is stretched to 0.5 m from its resting position.

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2 marks
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g) In cooling a cold drink, it is more effective to use ice cubes than cold water of the same mass and temperature as the ice cubes. Explain why?

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h) Below is a graph showing the temperature change and the heat energy involved in heating 15 kg of a particular plastic in solid state.

![Graph showing temperature change and heat energy](image)

Use the above information to calculate the specific heat capacity of the plastic.

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i) A sample of carbon dioxide gas occupies a volume of 3.50 L at 125 kPa pressure. The volume was decreased to 2.00 L and the temperature was maintained constant at 23°C.

i) Calculate the new pressure exerted by this sample of carbon dioxide.

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i) In terms of force from gas particles colliding with each other, explain why decreasing the volume increases the pressure when the temperature is kept constant.

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a) Use the following circuit diagram to answer the questions that follow.

i) When switch S is closed, show with an arrow the direction the electrons flow through the 8 Ω Resistor.

ii) What is the effective resistance of the circuit?

iii) When switch S is closed, what is the ammeter reading?

iv) Calculate the power output of the 20 Ω Resistor.
v) Predict which of the two parallel resistors would dissipate the most electrical energy as heat energy in two (2) minutes? Justify your answer.

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b) Two parallel wires X and Y carry a current of 2.5 A each as shown in the diagram below.

\[
\begin{align*}
\text{X} & \quad 2.5 \text{ A} \quad \text{Y} \\
\end{align*}
\]

Draw the resulting magnetic field when wire X is placed close to wire Y.

\[
\begin{align*}
\text{X} & \quad \text{Y} \\
\end{align*}
\]

\[
\text{B} = 0.5 \text{ T}
\]

\[
\text{2 ms}^{-1}
\]

NR

NR

NR

1 mark
1

0
NR

NR

c) The currents are now removed and then wire Y of length 12 mm is placed and moved in an external magnetic field as shown below.
i) Calculate the emf induced in the wire.

________________________________________________________________________

1 mark
1
0
NR

ii) Explain any two ways of increasing the magnitude of the emf induced in the wire.

________________________________________________________________________

2 marks
2
1
0
NR

d) A rectangular coil of wire was placed in a magnetic field of strength 0.40 T. The length AB and BC are 8 cm and 4 cm respectively and each carry a current of 2.0 A.

What effect would reversing the direction of the current have on the rotation of the coil?

________________________________________________________________________

2 marks
2
1
0
NR
Two metal plates placed 2 cm apart were connected to a 240 V Power supply. A point charge of +30 µC was placed in the middle of the plates as shown below.

i) In the diagram above, draw the shape and direction of the electric field between the plates.

ii) Calculate the electric field strength between the plates.

iii) Calculate the size of the force experienced by the charge between the plates.
f) Three isotope of an element represented by, \( ^{22}_{10}X, ^{23}_{10}Y, \text{ and } ^{24}_{10}Z \). The half-life of isotope Z is 8 days.

i) **Isotope Y** undergoes nuclear transformation producing an alpha particle and another element W. Complete the following equation showing the correct mass number and atomic number of the products in the transformation of Y by alpha emission.

\[
^{23}_{10}Y \rightarrow \quad \quad + \quad \quad
\]

ii) A 40 gram sample of isotope Z was left undisturbed in a container. Calculate the amount remaining after 24 days.

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1 mark
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0
NR
SECTION B:  MULTIPLE CHOICE  20 marks

1. On the fold out flap at the back of this booklet, write the letter that corresponds to the answer which you consider is correct. An example is shown below.

   Example: If you consider B is correct, write it like this B

To change your answer from B to C cross out B and write the new answer by the box, like this:

2. Spend approximately 40 minutes in this section.

Questions 1-6 worth 1 mark each, questions 7-10 worth 2 marks each and questions 11-12 worth 3 marks each. Check the questions number carefully.

1. From the list below, which light ray would eject an electron with the greatest speed from a metal surface if all frequencies exceed the threshold frequency of the metal?

   A) Orange
   B) Red
   C) Green
   D) Violet

2. The diagram shows a set-up for observing the interference of light.

   If the set-up is unchanged, identify which monochromatic lights will produce the first bright fringe farthest from the central line?

   A) Orange
   B) Indigo
   C) Blue
   D) Green
3. Which of the following diagrams would give a zero value of force when a piece of wire of length \( l \) carrying a current \( I \) is placed in a uniform magnetic field strength \( B \)?

A) 
\[ \text{N} \quad \text{S} \]

B) 
\[ \text{N} \quad \text{S} \]

C) 
\[ \text{N} \quad \text{S} \]

D) 
\[ \text{N} \quad \text{S} \]

4. The diagram shows a set-up for observing the interference of light.

If the set-up is unchanged, identify which monochromatic lights will produce the first bright fringe farthest from the central line?

A) Orange
B) Indigo
C) Blue
D) Green
Use the following information to answer questions 5 and 6.

The following velocity-time graph shows the motion of an 800 kg car.

5. What is the net Force on the car at t = 7 s?
   A) 0.00 N
   B) 1120 N
   C) 1600 N
   D) 3200 N

6. What is the **average velocity** over the whole 10 s of motion?
   A) 2.0 ms\(^{-1}\)
   B) 4.0 ms\(^{-1}\)
   C) 10 ms\(^{-1}\)
   D) 20 ms\(^{-1}\)

7. Which of the following sketches best represents the relationship between pressure and absolute temperature of an ideal gas when the volume is kept constant?

   A) ![Sketch A]
   B) ![Sketch B]
   C) ![Sketch C]
   D) ![Sketch D]
8. A Form 6 student was given 4 x 100 Ω resistors. He was allowed by his teacher to connect these resistors in any way he would like to. By doing so, what is the possible least circuit resistance this boy may obtain?

A) 13 Ω  
B) 25 Ω  
C) 250 Ω  
D) 400 Ω

9. A 2 kg coconut falls and hits the ground at a speed of 10 ms\(^{-1}\) rebound at a speed of 5 ms\(^{-1}\). What is the upward force of the ground on the falling coconut if the time of their contact was 0.03 s?

A) 333 N  
B) 500 N  
C) 666 N  
D) 1000 N

10. A -12 µC charge is moved from point A to point B (distance of 150 mm) in a uniform electric field of strength 200 J/C.m as shown below.

What is the work done on moving the charge in this field?

A) 360 µJ  
B) 360 mJ  
C) 360 J  
D) 360 kJ

11. An object is first placed 20 cm infront of a convex mirror and then infront of a concave mirror, both with a focal length of 10 cm. Compare and contrast the properties of the observed images?

<table>
<thead>
<tr>
<th>Convex mirror</th>
<th>Concave mirror</th>
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<tr>
<td>A Real, Diminished</td>
<td>Real, Same size</td>
</tr>
<tr>
<td>B Virtual, Diminished</td>
<td>Real, Magnified</td>
</tr>
<tr>
<td>C Virtual, Diminished</td>
<td>Real, Same Size</td>
</tr>
<tr>
<td>D Virtual, Magnified</td>
<td>Real, Diminished</td>
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12. A traveller drags her luggage and follows others to the departing gate as shown below.

What is the work done on moving her luggage 10 meters forward?

A)  164 J  
B)  200 J  
C)  250 J  
D)  2500 J
ANSWER SHEET FOR
SECTION B

Remember you are to write in each box the letter of the correct answer only.

1. □ 7. □
2. □ 8. □
3. □ 9. □
4. □ 10. □
5. □ 11. □
6. □ 12. □

TONGA FORM 6 PHYSICS
EXAMINATION 2015

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