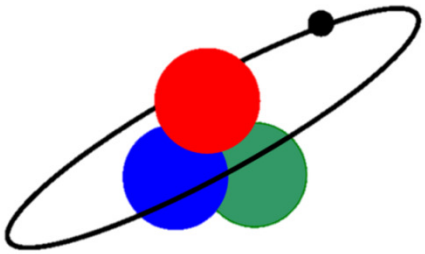

SAPhO

Full Report

on the

South African Physics Olympiad
SAPhO 2015

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for the

South African Institute of Physics
SAIP

1 Introduction

It has long been a goal to run a Physics Olympiad in South Africa to identify talent and, as stated in the "Shaping the Future of Physics in South Africa" report, SA should endeavour to set up a SA Physics Olympiad, SAPhO, with the aim of entering the International Physics Olympiad, IPhO. But as has been stated at several SAIP Conferences, the SA Education system is at this stage not in a position to enter the IPhO and it would make sense to first establish a fully functioning SAPhO before taking a quantum leap to the IPhO.

2 SAPhO Aim

South Africa, like every other country in the world, has amongst its youth, talented individuals, who need to be identified, nurtured and monitored so that these young people can optimise their contribution to SA's development, knowledge base and economy. Since it is generally accepted that Physics underpins all the sciences, it becomes important to identify talent in Physics. This leads to SAPhO with the aim of finding students who are capable of studying, and are interested in, Physics.

An important aspect of this process is nurturing and monitoring those identified, and both of these are very time consuming, expensive and difficult to do. However as a starting point it should be possible to monitor those students who were successful in the SAPhO, and who go on to tertiary education, to see how they compare with non-participating peers. It is hoped that in the future, Universities will take cognisance of students who have successfully competed in the SAPhO as this could make a significant contribution to encouraging less privileged students in Physics.

3 Planning SAPhO 2015

It was with the above in mind, that the first SAPhO was held during the International Year of Physics in 2005 and a full report on this appears on the SAIP website:

http://www.saip.org.za/images/stories/documents/SAPhO_Report.pdf

This went off extremely well and it was intended that it be followed upon a regular basis in subsequent years. Unfortunately for a variety of reasons, including assorted bureaucratic complications, lack of funding and trying to figure out a way to implement SAPhO that was simpler than the SAPhO 2005. It was clear that the SAIP did not have the capacity, administratively or financially, to run SAPhO from scratch for around 10 000, or more, students in a first round. So it was decided to repeat what was done in 2005, that with the assistance and cooperation of SAASTA, the annual SA National Youth Science Olympiad, SANYSO, would be used for selecting students to take part in SAPhO 2015.

Dr Jabu Nukeri, Managing Director of SAASTA, and Mr James Tlhabane who manages the SANYSO, were approached and asked if the results of the SANYSO could be used to select students for SAPhO 2015. This was agreed to so it was now possible to start planning and implementing SAPhO 2015. See letter at end of report.

Discussions were held with the SAIP on what awards were to be made and it was agreed:

The winner would receive a Gold Certificate, the SAIP Medal, R1 500 in cash and that the Medal would be presented at the Annual SAIP Conference dinner in Cape Town on 8 July 2016. Travel costs to be covered by the SAIP – provided the recipient was studying in SA.

Second place receives a Silver Certificate and R1 000,
Third place receives a Bronze Certificate and R 500,
Merit Certificates be awarded to those scoring between 3rd place and 50%,
Honourable Mention Certificates for those scoring between 49% – 40%, and
Participation Certificates for remainder.

4 SAPhO 2015

The SANYSO is usually written in March each year contains 50 MC questions on Physics and 50 MC questions on Chemistry and is distributed to over 19 000 students throughout SA and neighbouring countries. It is a massive logistical exercise and answers sheets are collected and marked in SA.
As the results of SANYSO are usually announced in June, it did mean that the SAPhO date could be set, and the SAPhO paper could be prepared in the meantime and that when the SANYSO results were released, students could be selected to write SAPhO.

It was decided that SAPhO would be written on Monday, 3 August, between 14h00 and 17h00. Just over 63 students were selected and Ndanganeni Mahani, the Projects Officer at the SAIP, then assisted in producing a list of 26 schools these students attended. A letter was sent to each school explaining what SAPhO was about and that the selected student(s) was(were) invited to write SAPhO, (see letters at end of report). In the end replies were received from 24 schools and that 59 students would write SAPhO, see Table 1 below.

Table 1 – Schools selected with numbers of students

School	**No**	**School**	**No**
Bishops	5	Matshumane Secondary School	1
Chisipite Senior School	3	Hoerskool Rustenburg	1
Machabeng College	3	King Edward Vii School	1
Mbilwi Secondary School	1	Pretoria High School For Girls	2
Privaatskool Moria	1	Horizon International High School	1
Star College Durban	12	King David Victory Park	1
Gateway School	3	St John's College	6
Makomborero Zimbabwe	4	Union High School	1
Westerford High School	2	Northcliff High School	1
El Shaddai Christian School	1	Ntabankulu SSS	4
Peterhouse Boys	2	St Albans College	1
Crawford College Pretoria	1	Erasmus Monareng High School	1
Total			**59**

Follow up letters were sent to these schools and arrangements for sending the exam and receiving the answers back were also made. It was decided that the question paper would be e-mailed to each school on the morning of the exam and ask the teacher in charge to print a copy for each student, as well as an answer sheet and a data sheet. Answer sheets were then either faxed to the SAIP office, or scanned and attached to an e-mail for marking. It was felt that this was probably as secure a method as was possible. One problem with this method of sending the answer sheets back was that they back in different sizes! This of course meant that the marking screen couldn't be used so it had to be done manually! This will need addressing for next year, 2016, when it is hoped to have about 150 – 200 students writing the SAPhO.

The draft paper was sent to Dr Spencer Wheaton, Physics Department, UCT, who moderated the SAPhO paper and made some valuable comments. The final paper is given below along with the answers, question distribution and some simple data analysis.

SA Physics Olympiad 2015

Time allowed: 1 ½ hours (90 minutes) **Answer all questions**

This paper contains 50 multiple choice questions with 5 possible alternatives marked (a) (b) (c) (d) and (e)

1 Please read the notes at the bottom of this page.

2 To answer a question, **cross** (**X**) out the letter you think represents the correct answer on the answer sheet supplied.

3 Use an HB **pencil**: do not use a pen, felt tip marker or ball-pen.

4 Each question has only **one** correct answer.

5 Marks will **not** be deducted for incorrect answers.

6 Use an eraser (rubber) to rub out an incorrect choice and re-mark the correct answer with a pencil. Make sure you have **not** marked **more than one** answer.

Notes

1 This is an Olympiad type of paper and is one that you cannot fail! It is aimed at finding potentially good physics students.

2 There may well be questions on topics that you have not "covered" in class. Other questions may be an extension of curriculum work, and you might need to spend a little time working them out.

3 Do not waste time on a question that you are struggling to answer. It is best to go through the paper and answer those questions that you can, and then return to the more difficult ones later.

4 For simplicity g = 10 $m.s^{-2}$ is usually used.

5 Should there be a tie for first place, the questions marked with an asterisk (*) will be used to resolve first place.

6 Simply do your best and be proud of the fact that you have got this far

1 Joyce stands in front of a mirror and wishes to see herself from head to foot. What is the shortest mirror that she can use if she is 1.6 m tall, stands 1.5 m from the mirror.

(a) 0.8 m
(b) 1.1 m
(c) 1.6 m
(d) 2.1 m
(e) 3.2 m

2 A ripple tank is used to show the interference of waves. The two dippers are set in a vibratory motion to produce waves of wavelength λ. The path difference of the waves to produce a maximum in the interference pattern is best described by:

(a) $(n - ½)\lambda$
(b) $(n + ½)\lambda$
(c) $n\lambda/2$
(d) $3n\lambda/2$
(e) $\mathbf{n}\lambda$

3 An oscillator generates waves along an elastic cord 20 cm long. Four complete waves fit along its length when the oscillator vibrates 30 times per second. The frequency and speed of the waves is:

	frequency	speed
(a)	30/4 Hz	1.5 $m.s^{-1}$
(b)	20 Hz	5.0 $m.s^{-1}$
(c)	30 Hz	1.5 $m.s^{-1}$
(d)	30 Hz	150 $m.s^{-1}$
(e)	30/4 Hz	15.0 $m.s^{-1}$

4 If a 1.00 kHz sound source moves at a speed of 50.0 m/s toward a listener who moves at a speed of 30.0 m/s in a direction away from the source, what is the apparent frequency heard by the listener?

(a) 796 Hz
(b) 949 Hz
(c) 1000 Hz
(d) 1068 Hz
(e) 1273 Hz

5 Two tuning forks are marked "C, 256 Hz". One is very old and has lost some of its "springiness". When both are struck and sounded together there is a beat frequency of 4 Hz. The actual frequency of the older tuning fork is most likely to be:

(a) 272 Hz
(b) 260 Hz
(c) 254 Hz
(d) 252 Hz
(e) 240 Hz

6 In order to produce an interference pattern, light from the two sources producing it must:

(a) be of equal intensity (brightness)
(b) white light with an equal amplitude
(c) travel the same distance
(d) be source and image of source or both be an image of the same source
(e) be polarized in the same way

7* Peter is standing on top of a tall building when he throws a cricket ball into the air. In which direction should he throw it so that it hits the ground with the maximum possible speed? Ignore the effects of air resistance.

(a) Straight up
(b) Straight down
(c) In a horizontal direction, away from the building
(d) Upwards at 45^{o} to the horizontal
(e) No matter what angle the ball is thrown it will always strike the ground at the same speed

8 The acceleration due to gravity, *g*, on Earth is 9.81 $m.s^{-2}$. What would you expect the value of *g* to be inside the Space Shuttle, when it is in orbit around the Earth, about 400 km above the Earth's surface and the astronauts inside are weightless:

(a) 0
(b) 0.0002 $m.s^{-2}$
(c) 1.12 $m.s^{-2}$
(d) 8.69 $m.s^{-2}$
(e) 9.81 $m.s^{-2}$

9 Which one of the following statements is true for a freely falling body?

(a) The average speed during the first second is 5 $m.s^{-1}$
(b) The acceleration increases by 10 $m.s^{-2}$ each second
(c) The displacement of the body increases by 10 m each second
(d) During each second the body falls 10 m
(e) The average acceleration during the first second is 5 $m.s^{-2}$

10 A lift is accelerating upwards at 2 $m.s^{-2}$. A ball is held 3 m above the floor of the lift and then released. How long before it hits the floor.

(a) $\sqrt{3}/2$ seconds
(b) ¾ seconds
(c) $2\sqrt{2}$ seconds
(d) $\sqrt{2}/2$ seconds
(e) ½ second

11* A particle is projected vertically upwards at a speed u. It is at a height h after time t and again after time T. The speed u is:

(a) $\frac{1}{2} g t^2$
(b) $\frac{1}{2} g (T + t)$
(c) $\frac{1}{2} g (T - t)$
(d) $\frac{1}{2} g (t - T)$
(e) $\frac{1}{2} g (T + t)^2$

12 The barrel of a gun is pointing directly at a target. If the target is dropped the instant the bullet leaves the barrel of the gun, then neglecting air resistance and assuming that the bullet can reach the target, it will:

(a) pass above the target
(b) pass below the target
(c) only hit the target if the bullet and target reach the ground at the same time
(d) always hit the target
(e) only hit the target if the barrel is level

Use the following information to answer questions **13** and **14**. A car is travelling at a steady speed of 100 km/h when it passes a stationary motorcyclist. The instant the car passes the motorcyclist, he sets off in pursuit of the car, accelerating uniformly, and overtakes the car after t seconds.

13 Which of the following must be the same for the car and the motorcyclist the instant the motorcyclist passes the car:

(a) their speed and their travel time t
(b) their speed and the distance travelled
(c) t and the distance they travelled
(d) only t
(e) only their speeds

14 What is the speed of the motorcyclist as it passes the car?

(a) 100 km/h
(b) just more than 100 km/h
(c) 200 km/h
(d) unable to work it out since the value of t is not known
(e) unable to work it out since the distance travelled by the motorcyclist is not known

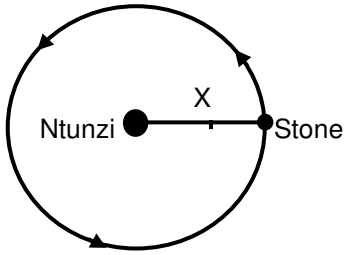
15* A ball is kicked on level ground at an angle θ. It lands after travelling D m and reaches a height h. The ratio h/D is:

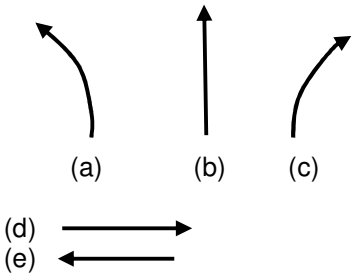
(a) tan θ
(b) ½ tan θ
(c) ¼ tan θ
(d) 4 sin 2θ
(e) ¼ sin θ

16 A toy bear is hung from the rear view mirror of a car by a piece of string. When the car accelerates at ***a*** the string is at an angle α with the vertical. Which one of the following is true?

(a) $\tan \alpha = 1/g$
(b) $\tan \alpha = 1/a$
(c) $\tan \alpha = a$
(d) $\tan \alpha = a/g$
(e) $\tan \alpha = g/a$

17 Ntunzi ties a stone to a piece of string and swings it around her head in a horizontal circle as shown below. In which direction does the stone start to travel after the string breaks at X?





18 A Formula 1 racing car has momentum p and kinetic energy U_K when it crashes into the tyre barrier and comes to rest after travelling d metres in t seconds. What was the average force exerted on the car during the crash?

(a) $U_K.d$
(b) U_K / d
(c) $p.d$
(d) p/d
(e) p/t

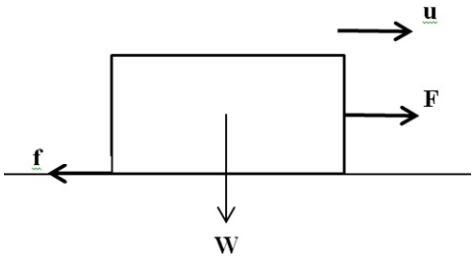
19* A car with a mass of 1 200 kg is freewheeling down a road sloping at 30° to the horizontal and reaches a steady speed of 54 km/h. What is the power of the car's engine if it is travelling along a horizontal road at the same speed and all other conditions are unchanged?

(a) 18 kW
(b) 65 kW
(c) 78 kW
(d) 90 kW
(e) 156 kW

20 Two bodies A and B attract each other with a gravitational force of *F* newtons when they are a distance *R* apart. If the mass of A is doubled, the mass of B is tripled and distance between them is doubled, then the force between A and B will be:

(a) 3*F*
(b) 3*F*/2
(c) 3*F*/4
(d) 6*F*
(e) 9*F*

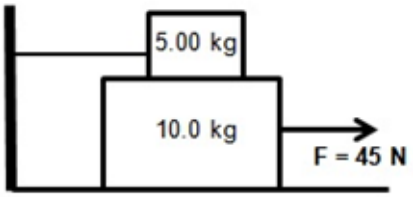
21



The diagram shows a box of weight **W** sliding over a rough surface at a constant speed **u** by a force **F** against a frictional force of **f N**. Which one of the following statements is true?

(a) f ∝ area
(b) f ∝ mass
(c) f ∝ speed
(d) f ∝ weight and area
(e) f < F otherwise **u** would decrease.

22* A 5.00 kg block is placed on a 10.0 kg block in the figure below. A horizontal force of 45.0 N is applied to the 10.0 kg block, and the 5.00 kg block is tied to the wall. The coefficient of kinetic friction between all moving surfaces is 0.200. Determine the tension in the string.



(a) 5.00 N
(b) 50.0 N
(c) 10.0 N
(d) 7.20 N
(e) 6.45 N

23* The pulley system shown is frictionless and the pulley has negligible mass. When released the masses have an acceleration *a*. The value of *m* is:

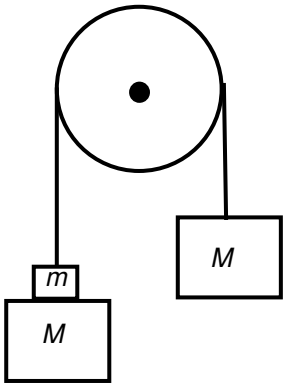
(a) $\dfrac{2M}{\frac{g}{a} - 1}$

(b) $\dfrac{2Ma}{g}$

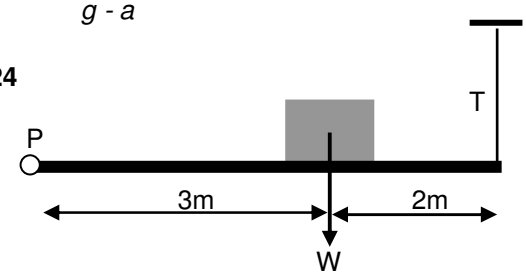
(c) $\dfrac{Ma}{2g}$

(d) $\dfrac{2Ma}{a - g}$

(e) $\dfrac{2Mg}{g - a}$



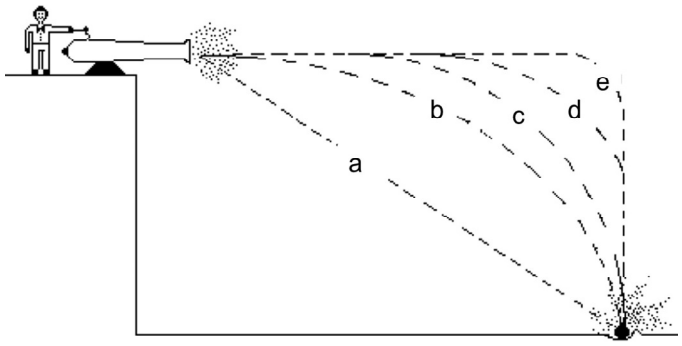
24



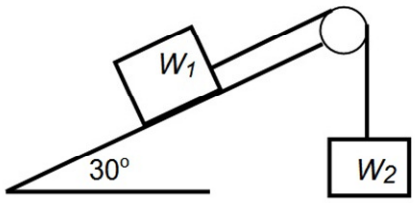
The diagram above shows a uniform beam of weight *W*, pivoted at point P and supporting a block of weight *W* as shown. The tension *T* in the string is:

(a) 3*W*/5
(b) 5*W*/2
(c) 11*W*/6
(d) 10*W*/11
(e) 11*W*/10

25 A ball is fired from a cannon on the top of a cliff as shown in the figure below. Which of the paths will the ball most closely follow.



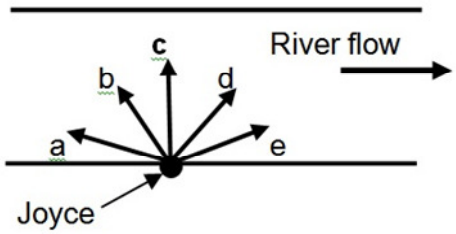
26*



The diagram above shows two blocks. One of weight W_1 on an inclined plane and W_2 hanging from a string. All surfaces are smooth and the pulley and string are light. Which one of the following statements is true?

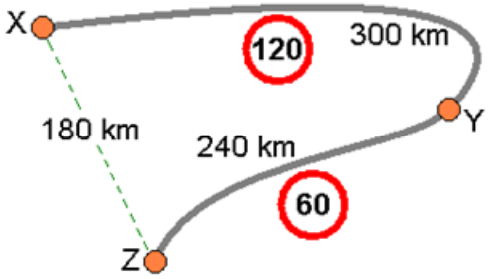
(a) The tension in the string is always W_2
(b) The tension in the string is $W_1 - W_2$
(c) If $W_1 > W_2$ then W_1 will always move up the plane
(d) If $W_1/2 = W_2$ then the blocks remain stationary
(e) If $W_1 = W_2$ motion can be in either direction.

27



Joyce wants to swim to the opposite bank of the river. In which direction should she swim if she wants to do this in the shortest possible time.

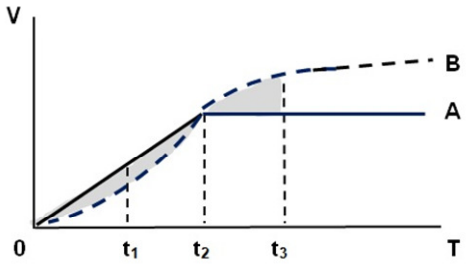
28 A car travels the 300 km distance from X to Y at a constant speed of 120 km/h. It then stops at Y for 1 hour. It starts again and travels the 240 km from Y to Z at a constant speed of 60 km/h. The shortest distance from X to Z is 180 km. How long does the trip from X to Z take?



(a) 3 hours
(b) 6 hours
(c) 6.5 hours
(d) 7 hours
(e) 7.5 hours

Use the V - T graph and information below to answer questions 29 and 30

Car A (solid line) and Car B (broken line) are having a race. They start at the same place when $T = 0$. The velocity versus time graph for the two cars is illustrated by the solid and broken lines in the diagram. The two lines have the same slope at t_1 and t_3 is the time where the shaded areas have exactly the same area.



29 At what time, other than when they started, do the two cars have the same speed**?**

(a) At t_1
(b) At a time between t_1 and t_2
(c) At t_2
(d) At a time between t_2 and t_3
(e) At t_3

30 At what time do the two cars pass each other?

(a) At a time between t_1 and t_2
(b) At t_2
(c) At a time between t_2 and t_3
(d) At t_3
(e) Sometime after t_3

31 In a thundercloud, there may be electric charges of +40.0 C near the top of the cloud and -40.0 C near the bottom of the cloud. These charges are separated by 2.00 km. What is the electric force on the top charge?

(a) $3.60 \times 10^{+4}$ N upward
(b) $3.60 \times 10^{+4}$ N downward
(c) $3.60 \times 10^{+6}$ N upward
(d) $3.60 \times 10^{+6}$ N downward
(e) $3.60 \times 10^{+5}$ N downward

32 If one, two or three identical resistors can be connected in series, in parallel or in any combination of these, how many different values of resistance can be created?

(a) 3
(b) 4
(c) 5
(d) 6
(e) 7

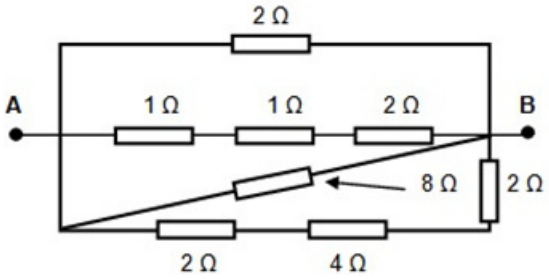
33 Three resistors, X, Y and Z are connected in parallel, with the resistance of X < Y < Z. The value of the equivalent resistance *R* of the parallel combination is:

(a) $R > Z$
(b) $R = Y$
(c) $R < X$
(d $R = \frac{1}{X} + \frac{1}{Y} + \frac{1}{Z}$
(e) $R = \frac{X + Y + Z}{XYZ}$

34 A transformer has 100 turns in the primary coil and 2 000 turns in the secondary coil. If an alternating potential difference of 12 V is applied across the primary, the potential difference across the secondary will be:

(a) 0.6 V
(b) 6 V
(c) 240 V
(d) 480 V
(e) 2 400 V

35 For the circuit shown below, the resistance between points A and B is, in ohms:



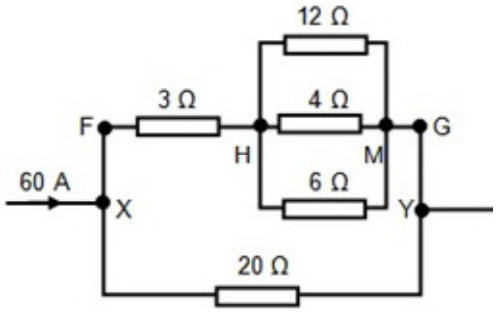
(a) 1
(b) 24/25
(c) 2
(d) 4
(e) 8

36*If *E* is the emf of a cell, *n* the number of cells, *r* the internal resistance of each cell and *R* an external resistance, then the current *I* in a circuit where these components are connected in series is:

(a) $\frac{nE}{(R+nr)}$ (b) $\frac{nE}{(R+r)}$ (c) $\frac{E}{(R+r)}$

(d) $\frac{nE}{\left(R+\frac{r}{n}\right)}$ (e) $\frac{E}{(R+nr)}$

Use the circuit diagram below to answer questions **37, 38 and 39**. A current of 60 A is supplied to the circuit as shown, entering at X and exiting at Y.



37 What is the potential difference between points F and G?

a) 24 V
(b) 48 V
(c) 96 V
(d) 144 V
(e) 240 V

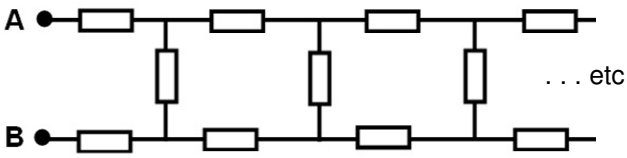
38 What is the current through the 6Ω resistor?

(a) 8 A
(b) 12 A
(c) 16 A
(d) 24 A
(e) 48 A

39 The 4Ω resistor between H and M is now shorted out. What is the power dissipated by the 20Ω resistor?

(a) 1 226 W
(b) 4 840 W
(c) 6 935 W
(d) 13 224 W
(e) 72 000 W

40*The diagram below shows an infinite ladder of resistors each of value *R* Ω. What is the effective resistance between the points **A** and **B**?



(a) $(\sqrt{3} - 1)R$
(b) $(\sqrt{3} + 1)R$
(c) R
(d) $2/\sqrt{3}$ R
(e) $2R/\sqrt{3}$

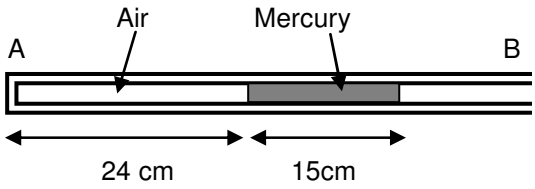
41* A raindrop of mass *m* falls to the ground at a terminal speed *v*. The specific heat capacity of water is *c* and the acceleration due to gravity is *g*. Given that 25% of the energy is retained by the raindrop when it strikes the ground, what is the rise in temperature of the raindrop?

(a) $\frac{mv^2}{8c}$ (b) $\frac{v^2}{4mc}$

(c) $\frac{mg}{4c}$ (d) $\frac{v^2}{8c}$

(e) $\frac{v^2 g}{8m}$

42 The diagram below shows a 15 cm thread of mercury in a capillary tube used to trap a fixed mass of air. The air column is 24 cm long when the tube is horizontal and the air pressure is 75 cm of mercury. The tube is now mounted vertically with the closed end A at the top. If the temperature stays constant, what is the length of the trapped air column now?



(a) 18 cm
(b) 24 cm
(c) 30 cm
(d) 36 cm
(e) None of the above: the mercury will fall out of the tube.

43 A heater is put into a block of metal X of mass 1 kg and the temperature rises by 2 K. When the same heater is used to heat 0.5 kg of another metal Y for the same time its temperature rises by 1 K. The specific heat capacity of Y is

(a) four times that of X
(b) twice that of X
(c) the same as that of X
(d) half that of X
(e) one quarter that of X.

44 What is another name for the Helium nucleus?

(a) proton,
(b) neutron
(c) beta particle
(d) alpha particle
(e) gamma particle

45 Beta decay can occur when a neutron in a radioactive nucleus splits into a proton and an electron. What else is emitted in this process?

(a) Only a photon
(b) Only a neutrino
(c) A neutrino and a photon
(d) An anti-neutrino and a photon
(e) Only an anti-neutrino

46 The age of wood can be found by comparing the amount of carbon-14 a sample contains to the amount of carbon-14 in a fresh piece of wood. Such a piece of wood contains 8 times the amount of carbon-14 as a sample from an ancient campfire. How many years ago was the campfire burning if the half-life of carbon-14 is 5 600 years?

(a) 44 800 years
(b) 22 400 years
(c) 16 800 years
(d) 11 200 years
(e) 700 years

47 Radiation of frequency 10^{15} Hz shines on the surface of a metal whose work function is 1 eV (1.6×10^{-19} J). Which one of the following retarding potential differences would prevent the ejection of a photo-electron:

(a) 1 V
(b) 2 V
(c) 3 V
(d) 4 V
(e) 5 V

48 When light shines on a metal surface, electrons will be emitted if the wavelength is less than or equal to λ. When light of wavelength $\lambda/2$ shines on the same metal, the maximum kinetic energy of ejected electrons is *T* J. When light of wavelength $\lambda/3$ shines on the metal, the maximum kinetic energy of emitted electrons is:

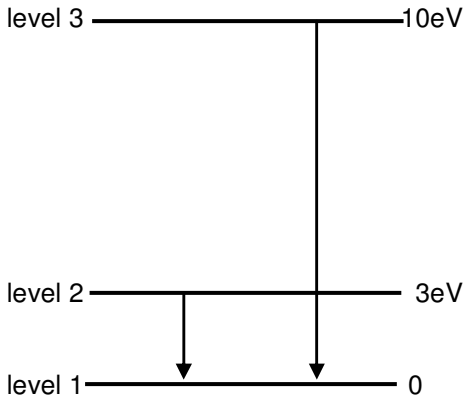
(a) $2T/3$ (b) $\sqrt{\frac{2}{3}}T$ (c) $3T/2$

(d) $2T$ (e) $3T$

49* In a photo-electric experiment the energy of a photo-electron can be measured by applying a sufficient potential difference V to prevent the emission of the electron from the metal surface. Light of different wavelength λ (frequency *f*) is shone onto the metal and each time the potential difference required to stop emission is measured in volts. A straight line graph is produced by plotting:

(a) V^2 against λ
(b) V against λ
(c) λ against 1/V
(d) V^2 against *f*
(e) V against *f*

50* The diagram below shows three of the energy levels of an atom. A transition from level 2 to level 1 results in the emission of a photon of blue light. A transition from level 3 to level 1 could result in the emission of a photon of:



(a) γ-radiation
(b) X-rays
(c) ultra-violet light
(d) red light
(e) infra-red light.

6 Answers and Analysis

1a	**2e**	**3c**	**4d**	**5d**
6d	**7e**	**8d**	**9a**	**10d**
11b	**12d**	**13c**	**14c**	**15c**
16d	**17b**	**18e**	**19d**	**20b**
21b	**22c**	**23a**	**24e**	**25b**
26d	**27c**	**28e**	**29c**	**30d**
31d	**32e**	**33c**	**34c**	**35a**
36a	**37e**	**38c**	**39a**	**40b**
41d	**42c**	**43a**	**44d**	**45d**
46c	**47d**	**48d**	**49e**	**50c**

Distribution of answers:

(a) 7
(b) 6
(c) 13
(d) 16
(e) 8

6.1 Table 2 – gives the number of correct answers for each question

Quest	Ans	Quest	Ans	Quest	Ans	Quest	Ans	Quest	Ans
1	15	11	14	21	23	31	31	41	15
2	16	12	18	22	27	32	32	42	12
3	40	13	38	23	7	33	33	43	17
4	21	14	9	24	4	34	34	44	42
5	39	15	8	25	39	35	35	45	5
6	14	16	36	26	36	36	36	46	30
7	21	17	37	26	19	37	37	47	9
8	16	18	38	28	30	38	38	48	7
9	35	19	23	29	49	39	39	49	16
10	24	20	50	30	31	40	40	50	28

Summary of marks

1 Average for SAPhO = 43%
2 Range of Marks: 74% - 22%

6.2 Table 2 – Note that the totals don't always add-up to 59 as some questions weren't answered and some had multiple answers.

Quest	a	b	c	d	e	Total
1	15	23	12	5	4	59
2	5	14	14	8	16	57
3	4	4	40	7	4	59
4	9	8	11	21	8	57
5	2	7	5	39	4	57
6	9	9	9	14	17	58
7	11	12	5	9	21	58
8	19	10	6	16	6	57
9	35	5	13	4	1	58
10	13	8	4	24	7	56
11	2	16	23	7	10	58
12	12	4	8	18	16	58
13	1	1	38	15	1	56
14	2	11	9	24	9	55
15	22	25	9	1	1	58
16	0	6	8	36	6	56
17	8	37	9	4	0	58
18	2	9	3	3	38	55
19	6	10	8	23	11	58
20	2	50	2	3	1	56
21	3	23	5	15	12	58
22	15	2	27	11	2	57
23	7	8	11	14	16	56
24	27	13	6	6	4	56
25	4	39	13	2	0	58
26	5	6	4	36	5	56
27	1	20	19	12	4	56
28	7	3	11	4	30	55
29	1	1	49	4	3	58
30	2	9	5	31	10	57
31	2	5	13	31	5	56
32	6	8	10	25	9	58
33	6	2	33	9	7	56
34	8	3	41	2	2	56
35	33	8	9	4	2	56
36	28	12	7	5	5	57
37	4	9	7	8	34	56
38	5	15	28	7	2	57
39	6	19	12	9	8	54
40	5	13	18	9	11	56
41	11	9	13	15	7	55
42	3	9	12	9	22	55
43	17	10	15	5	10	57
44	2	3	5	42	4	56
45	16	8	21	5	8	58
46	12	6	30	5	5	58
47	12	14	8	9	13	56
48	10	14	24	7	1	56
49	5	12	14	7	16	54
50	8	9	28	7	6	58

6.3 Table 3

#	Comment
1	Easiest question! Strange why (b) was the most frequent answer. Clear weakness in light.
2	Good question with 2 good detractors. More than ½ thought answer was a multiple of n/2.
3	Well answered and obviously well understood.
4	It is clear the Doppler effect was not well understood.
5	Well answered and obviously well understood
6	Poorly understood – distribution might indicate guessing! Language problem?
7	Good question – those who used energy probably got it right – others probably guessed!
8	Probably misconceptions here distribution could indicate guessing.
9	Well answered and straight forward question. Interesting that 13 chose (c) – velocity!
10	Good question – errors probably due to incorrect sign for g
11	Good question – errors probably due to wrong signs for directions
12	Good question – (a) and (e) were good detractors
13	Most got the right – well understood.
14	Most got this wrong! Had they drawn the V-T diagram . . .
15	Tough question, but . . . most got it wrong – simply took tan θ =opp/adj !
16	Most got this right – they took tan θ =opp/adj !
17	Most got this right – as expected.
18	Unexpectedly well answered – which was great to see!
19	Good question – and the distribution shows that a number probably guessed!
20	Good to see that students were able to handle ratio/proportions well.
21	Good question with two good detractors.
22	Good question with two good detractors – distribution shows some guessing.
23	Connected particles are poorly understood. Also weak mathematics of solving eqns evident.
24	Poorly answered. Suspect most didn't use the weight of the plank/didn't know where to apply it
25	Straight forward – answers showed the expected misconception.
26	Unexpectedly well answered! Maybe because sin 30 = ½ ! Maybe should use angle as θ
27	Reflect common misconception between shortest time and distance and poor components work
28	Easy question – suspect some misread the diagram.
29	Easy question – well answered.
30	Straight forward.
31	On the whole well answered
32	One wonders which combination they missed. Should draw out all possibilities!
33	Parallel resistors are clearly understood.
34	Easy question well answered.
35	Parallel resistors are clearly understood.
36	Well answered
37	Well answered
38	Well answered – this clearly shows that candidates had a good grasp of circuits.
39	But here I think many simply took out the 4 Ω resistor.
40	The most difficult question in the exam. Distribution shows most probably guessed.
41	Not easy – and suspect many guessed as SHC is not generally covered.
42	Tough question – I think those that didn't guess thought the Hg would fall out!
43	Not easy – and suspect many guessed as SHC is not generally covered.
44	Easy – simple recall.
45	Many probably didn't distinguish between a neutrino and an anti-neutrino!
46	Straight forward – fairly well answered.
47	The photoelectric effect not well understood – distribution shows most probably guessed.
48	Most seemed to have taken the ratio of λ/2 and λ/3.
49	The photoelectric effect not well understood – distribution shows most probably guessed.
50	Well answered.

7 Awards and Presentations

Once the marking was complete and the results checked, the schools were notified of the results (see letter at end) and the schools with winning students, namely St Johns College, JHB and Mbilwi Senior Secondary School, were sent individual letters of congratulation and certificates were handed out to these winning individuals by SAIP President Prof Azwinndini Murunga accompanied by SAIP Project Officer Ndanganeni Mahani, both ex-students from Mbilwi HS!

Mbilwi pupil hoists the school's flag high

Date:11 September 2015 - **By:** Elmon Tshikhudo

Read: 6895

A Grade-12-pupil at Mbilwi Secondary School, one of the best-performing schools in the country, has made his school and community very proud after winning a top international science competition.

Hamandishe Mathivha (17) of Sibasa started his winning spree by winning the National Science Olympiad while in Grade 10 in 2013. For his achievement, he won a trip to London. In 2014, he won the competition for the second time and went to Australia as part of his prize.

This year he won the competition once more and received R40 000 in prizes. The Minister of Science and Technology, Ms Naledi Pandor, congratulated him, referring to him as a "science olympiad veteran". As if that was not enough, Mathivha also won a prize in the Physics Olympiad, hosted by the South African Institute of Physics (SAIP). He came second, winning himself a silver certificate and R1000 in cash for his efforts. As part of their prizes, the winners will also attend a conference in Cape Town next year.

The prizes were handed over at the school on Monday by the president of the South African Physics Olympiad and also a former pupil of Mbilwi, Prof Azwindini Muronga of the University of Johannesburg. Muronga said the competition was aimed at raising awareness in physics and its importance in people's daily lives. He said it was also aimed at identifying pupils with ability in physics with the aim of encouraging them to follow it at tertiary level.

The ecstatic principal of the school, Mr Cedric Lidzhade, could not hide his happiness. "We are a winning school and this is history for our school. We are so excited as this will also encourage other pupils to study harder and to enter competitions," he said.

The above indicates that there was good local coverage after the release of a press release, See end of report. Below is another image of the event at Mbilwi School.

Mbilwi Senior Secondary School Silver Medal Prize Handover 07 September 2015

From left in front, Mr Lidzhade (headmaster), HY Mathivha (SAPhO 2nd position Silver Award winner, Prof A Muronga (SAIP), Mr Tshivhase (Circuit Manager), Mrs Mathivha (Parent). Back from left 1. Educator (unknown) 2. Ms Mahuluhulu(educator) 3. Mrs Sankaran (deputy principal) and far right, Mrs Rene Kotze (NITheP).

It was also most pleasing that Ms Rene Kotze from the National Institute of Theoretical Physics, NITheP, in Stellenbosch, attended the ceremony.

The awards ceremony at St John's College took place on 15 September, with from L to R:

Prof Simon Connell, Logan Geldenhuys, Gold Certificate, Mr Brian Masara, SAIP Executive Officer, Dr Colleen Henning, HoD Science at St John's College, Mr Paul Edey, St John's College Headmaster and Keanu Spies, Bronze certificate.

Logan Geldenhuys will be presented with his Olympiad Medal at the 2016 SAIP Conference in Cape Town, see below.

The SAIP SAPhO medal.

8 Future

It is probably fair to say that SAPhO 2015 was a success and that this is certainly an effort worthwhile continuing with. But it will need more support from the Universities – not financial, but "in kind" by way of:

8.1 contributing to the data base of questions,
8.2 looking at students who have successfully participated in SAPhO a little more closely when they apply for studies at a SA University.

Both of the above will make a significant contribution to the sustainability of SAPhO and as a result go some way towards achieving the goals set out in the "Shaping the Future of Physics in SA" document

So SAASTA will again be approached this year to use the SANYSO as a selection process for SAPhO 2016. The 2016 Exam paper is already being drafted and should be ready for moderation early 2016. Through the involvement of the SAIP and SAPhO in the DST's Science, Technology, Engineering, Mathematics and Innovation Organization, STEMIO*, it will be possible to expose other students to SAPhO and so diversify and broaden our student base for participation in SAPhO. By coincidence SAPhO this year took place during National Science Week, NSW, and it is planned to have SAPhO 2016 as part of NSW 2016. Funding through STEMIO might be possible in future, but in the meantime it will be important for the SAIP to be able to support SAPhO in the short term.
* See separate report.

9 Acknowledgements

First and foremost SAIP Council members, in particular past president Dr Igle Gledhill and current president Prof. Azwinndini Muronga. SAIP Executive Officer Mr Brian Masara for always being there to help and advise, and Ms Ndanganeni Mahani, SAIP Project Officer, who carried the burden of much of the administration willingly and efficiently: SAPhO 2015 would not have been the success it was without her help.

Secondly Dr Jabu Nukeri of SAASTA who enabled SAPhO 2015 to actually happen and I look forward further cooperation with SAASTA and Mr James Tlhabane who made the SANYSO results available for SAPhO selection.

Finally, Profs Hartmut Winkler and Andre Venter for contributing to the question data base and Dr Spencer Wheaton for moderating the final SAPhO paper.

Thank you.

The South African Physics Olympiad

The South African Institute of Physics, SAIP, is the voice for Physics in South Africa. It is a professional body for practising physicists in a variety of disciplines ranging from Cosmology to Medical Physics. It has several goals, one of which is raising the awareness of Physics and its importance to our daily lives; which can be achieved through education.

This Olympiad is hosted by the SAIP with the aim of identifying young South Africans with ability in Physics, in the hope that these students will continue to study Physics at tertiary institutions and universities within South Africa. SA, like many other countries, has a need for expertise in STEM, and in particular, SA has started some major international collaborations, including the Square Kilometre Array, SKA, the Southern African Large Telescope, SALT, Laser Technology, Electron Microscopy and ITC: these all require highly skilled scientists. We should aim to use and develop our own talent, and this starts at school level by finding young people with ability in Physics, since Physics underpins all other sciences.

Using the results of the SA National Youth Science Olympiad, SANYSO, hosted by SAASTA, 60 learners from 26 schools were selected from the nearly 19 000 learners that wrote the SANYSO, to write the 50 question Multiple Choice SA Physics Olympiad, SAPhO, on 3 August, 2015.

The results and awards, announced on 18 August, 2015 were as follows:

Winner	L Geldenhuys	St John's College, JHB.	74%
Second	H Y Mathivha	Mbilwi Sec. School, Sibasa	70%
Third	K Spies	St John's College, JHB.	62%

The average mark for SAPhO was 43% and the range of marks was 74% - 22%

The winner, L Geldenhuys, will receive a Gold Certificate, the SAIP Medal, R1 500 and will be presented with his medal at the Annual SAIP Conference dinner in Cape Town on 8 July 2016.

Second place receives a Silver Certificate and R1 000
Third place receives a Bronze Certificate and R 500

Merit Certificates be awarded to those scoring between 50% – 61%,
Honourable Mention Certificates for those scoring between 40% – 49%, and
Participation Certificates for remainder.

The learners from St. John's College, JHB, L Geldenhuys and K Spies will be presented with their certificates by Prof. Simon Connel, UJ and H Y Mathivha will be presented with his certificate by Prof. Azwinndini Muronga, UJ and President of SAIP.

These results were most satisfactory and it is hoped that next year the SAPhO can be extended to about 150 learners.

A number of staff, at both the SAIP and SAASTA, are thanked for their support and making the SAPhO the success that it was.

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