# Secondary School Mathematics \＆Science Competition 2014 

## Physics

| Date | $: 17^{\text {th }}$ May 2014 | Total no．of pages | $: 19$ |
| :--- | :--- | :--- | :--- |
| Time allowed | $: 11: 45 \mathrm{am}-1: 00 \mathrm{pm}$（1hour 15 minutes） | Total marks | $: 50$ |

1．Write your Candidate Number，Centre Number，Name（both in English and Chinese），Name of School，Form，Date，Gender，Language and Subject in the spaces provided on the MC Answer Sheet and the Part B Answer Sheet．

2．When told to open this question paper，you should check that all the questions are there．Look for the words＇END OF PAPER＇after the last question．

3．Answer ALL questions in Part A．You are advised to use an HB pencil to mark your answers on the MC Answer Sheet．

4．You should mark only ONE answer for each question in Part A．If you mark more than one answer， you will receive NO MARK for that question．

5．Answer ALL questions in Part B．You should write your answer on the Part B Answer Sheet．
6．No mark will be deducted for wrong answers．
7．The diagrams in the paper are not necessarily drawn to scale．

## Part A: Multiple Choice Questions

1. Steam at $100^{\circ} \mathrm{C}$ is injected into a melting ice block of the same mass. Assume that no energy is lost to the surroundings. What is the state of the mixture?

Specific heat capacity of water $=4200 \mathrm{~J} \mathrm{~kg}^{-1}{ }^{\circ} \mathrm{C}^{-1}$
Specific latent heat of fusion of ice $=3.34 \times 10^{5} \mathrm{~J} \mathrm{~kg}^{-1}$
Specific latent heat of vaporization of water $=2.26 \times 10^{6} \mathrm{~J} \mathrm{~kg}^{-1}$
A. A mixture of ice and water at $0^{\circ} \mathrm{C}$.
B. Water at a temperature below $50^{\circ} \mathrm{C}$.
C. Water at a temperature higher than $50^{\circ} \mathrm{C}$.
D. A mixture of steam and water at $100^{\circ} \mathrm{C}$.
2.


A heat sink (see figure above) cools down an electric device by absorbing the waste heat generated. Consider three heat sinks of identical size and made of the following materials. Which material produces heat sink with the best performance?

| Material | Specific heat capacity <br> $\left(\mathbf{J ~ k g ~}^{\mathbf{- 1}} \mathbf{}^{\mathbf{- 1}} \mathbf{)}\right.$ | Density <br> $\left(\mathbf{k g ~ m}^{\mathbf{- 3}}\right)$ | Melting Point <br> $\left({ }^{\circ} \mathbf{C}\right)$ |
| :---: | :---: | :---: | :---: |
| Aluminium | 900 | 2700 | 660 |
| Zinc | 390 | 7140 | 420 |
| Copper | 370 | 8900 | 1084 |

A. Aluminium, because it has the highest specific heat capacity.
B. Copper, because it has the lowest specific heat capacity.
C. Zinc, because it has the lowest melting point.
D. Copper, because the heat sink produced has the highest heat capacity.
3.


Fibre-glass coverings consist of a large amount of fine glass fibres. Such coverings laid on the floor, walls and ceiling of a house can greatly reduce heat loss to the surrounding. Which of the following is/are the reason(s) for this?
(1) The specific heat capacity of glass fibre is small.
(2) Glass fibres with trapped air are very poor conductors of heat.
(3) Fibre-glass radiates a lot of energy.
A. (1) only
B. (2) only
C. (1) and (2) only
D. (1) and (3) only

## 4. Convection causes

A. sea breezes.
B. tsunamis.
C. a drop of ink to spread out in still water.
D. lava to flow downhill.


The gas pressure in a car tyre is 305 kPa when its temperature is $15^{\circ} \mathrm{C}$. After running at high speed, the tyre is heated up and the pressure in the tyre becomes 400 kPa . What is the final temperature of the gas in the tyre? Assume the volume of the tyre is constant.
A. $\quad 19.6^{\circ} \mathrm{C}$
B. $\quad 104.7^{\circ} \mathrm{C}$
C. $\quad 288{ }^{\circ} \mathrm{C}$
D. $377^{\circ} \mathrm{C}$
6.


An object is projected horizontally from the edge of a table, as shown above. The figure shows the trajectory of the projectile. Its horizontal displacement is $a$ at $P$ and $b$ at $Q$. If the initial speed is $u$, what is the vertical displacement $h$ from $P$ to $Q$ ? Neglect air resistance.
A. $\frac{g}{2 u^{2}}\left(a^{2}+b^{2}\right)$
B. $\frac{(a+b) u^{2}}{4 g}$
C. $\frac{g}{2 u^{2}}\left(b^{2}-a^{2}\right)$
D. $\frac{\left(b^{2}-a^{2}\right) u^{2}}{2 g}$


A Hong Kong Peak Team is pulled by ropes and runs between the Lower Terminal ( 28 m above the sea level) and the Upper Terminal ( 396 m above the sea level). The gradient of the track is not uniform and varies between $4^{\circ}$ to $27^{\circ}$ to the horizontal. To find the work done by a rope to pull a tram to the Peak, which of the following information is/are also required? Assume the tram moves at a constant speed.
(1) Mass of the tram
(2) Total length of the path
(3) Average friction acting on the tram
A. (1) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
8. $\quad A$ and $B$ are two planets. The masses of $A$ and $B$ are $m_{A}$ and $m_{B}$ respectively, and the radii of $A$ and $B$ are $r_{\mathrm{A}}$ and $r_{\mathrm{B}}$ respectively. Two identical objects are placed on the surfaces of the two planets. What is the ratio of the gravitational forces acting on the object on $A$ to that on $B$ ?
A. $\frac{m_{A} r_{A}}{m_{B} r_{B}}$
B. $\frac{m_{A} r_{B}}{m_{B} r_{A}}$
C. $\frac{m_{A} r_{B}^{2}}{m_{B} r_{A}^{2}}$
D. $\frac{m_{A} r_{A}^{2}}{m_{B} r_{B}^{2}}$
9.


When an aircraft makes a turn, it needs to tilt such that
A. the air resistance can be reduced.
B. the plane can move upwards.
C. part of the lifting force provides the centripetal force.
D. the oil consumption can be reduced.
10.


In the figure above, trolleys $X$ and $Y$ move at $7 \mathrm{~m} \mathrm{~s}^{-1}$ and $3 \mathrm{~m} \mathrm{~s}^{-1}$ respectively in the same direction. If the trolleys are stuck and move together at $4 \mathrm{~m} \mathrm{~s}^{-1}$ after collision, what is the ratio of the mass of $X$ to that of $Y$ ?
A. $2: 3$
B. $3: 4$
C. $1: 1$
D. $1: 3$
11.


When we use the scissors to cut an object, which of the following statements is correct?
A. The pivot is at the rotation axis in the middle of the scissors.
B. The forces applied by the hand form a couple.
C. The force applied on the scissors by the hand is always equal to the force applied on the object by the scissors.
D. The net torque about the pivot is zero.
12.


In the figure above, a $10-\mathrm{g}$ bullet travelling at a speed of $600 \mathrm{~m} \mathrm{~s}^{-1}$ penetrates a $20-\mathrm{cm}$ wooden block. If the bullet emerges from the block at $400 \mathrm{~m} \mathrm{~s}^{-1}$, what is the average friction provided by the wooden block on the bullet? Assume the air resistance is negligible.
A. 2990 N
B. 5000 N
C. 29900 N
D. 50000 N
13.


A basketball rebounds from the ground several times, after it falls vertically from a height of $h$ m . If the basketball loses $10 \%$ of total energy after each bounce, what is the maximum speed (in $\mathrm{m} \mathrm{s}^{-1}$ ) of the ball just after the third bounce?
A. $3.44 \sqrt{h}$
B. $3.62 \sqrt{h}$
C. $3.82 \sqrt{h}$
D. $4.02 \sqrt{h}$
14. A girl steps onto a weighing scale in a lift and the reading of the scale is 550 N . If her mass is 45 kg , which of the following may be happening?
A. The lift is moving up with acceleration $2.22 \mathrm{~m} \mathrm{~s}^{-2}$.
B. The lift is moving down with acceleration $1.8 \mathrm{~m} \mathrm{~s}^{-2}$.
C. The lift is moving at a constant speed of $2.22 \mathrm{~m} \mathrm{~s}^{-1}$.
D. The lift is moving up with deceleration $1.8 \mathrm{~m} \mathrm{~s}^{-2}$.
15. A police car is patrolling on a straight highway at $108 \mathrm{~km} \mathrm{~h}^{-1}$. When a speeding car travelling at $144 \mathrm{~km} \mathrm{~h}^{-1}$ passes the police car and is 10 m in front of it, the police car starts to accelerate and chases the speeding car. If the police car accelerates uniformly at $5 \mathrm{~m} \mathrm{~s}^{-2}$ and the speeding car moves with a constant speed, how long will it take for the police car to catch up with the speeding car?
A. 0.828 s
B. 4 s
C. 4.83 s
D. 7.2 s
16. Which of the following are the applications of radioisotopes?
(1) Radiotherapy
(2) Photocopying
(3) Carbon-14 dating
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
17. Which of the following statements about the Rutherford's atomic model are correct?
(1) The nucleus is much smaller than the atom.
(2) Most of the mass of an atom is concentrated in the nucleus.
(3) All positively-charged particles are concentrated in a tiny core.
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
18. Which of the following statements about the nuclear waste produced by the used nuclear fuel in a nuclear power plant is incorrect?
A. The nuclear waste is radioactive.
B. The nuclear waste does not need any special treatment.
C. The nuclear waste can be reprocessed to make weapons.
D. The nuclear waste poses a threat to the living organisms in its neighborhood for a very long period of time.
19.


A lens is used to look at some print on a paper. The image of the word "PHYSICS" is shown above. Which of the following statements is/are correct?
(1) The lens is a converging lens.
(2) The linear magnification is 3 .
(3) The image is virtual.
A. (1) only
B. (2) only
C. (3) only
D. All are incorrect.
20.


A vibrator generates a travelling wave on a string. In order to form a stationary wave, the string is fixed at $Q$ to produce an identical wave travelling in the opposite direction. The above figure shows the shape of the string at an instance when the antinode attains its maximum displacement from the equilibrium position. Which of the following shows the shape of the string between $P Q$ after a quarter of a period?
A.

C.

B.

D.

21. Which of the following statements concerning the infra-red radiation is correct?
A. Infra-red is red in color.
B. Infra-red can be used to sterilize drinking water.
C. Dry ice emits infra-red.
D. The frequency of infra-red is higher than the frequency of red light.
22.


The development graph of a paper camera is shown above. By combining the paper camera with a convex lens, a girl views far away objects outside the window as in the photo below. Which of the following statements concerning the properties of the final image are correct?

(1) The image is virtual.
(2) The image is inverted.
(3) The image is laterally inverted.
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
23. A longitudinal wave is travelling from left to the right in a medium. Fig. (a) shows the equilibrium positions of some particles $P, Q, R, S$ and $T$ in the medium. Fig. (b) shows the positions of the particles at a certain time $t=0$ when the wave is passing through them.


Taking the displacement to the right as positive. Which of the following graphs correctly shows the displacement-time relation of the particle $S$ ?




24.


In the figure above, a parallel light beam enters the lens on the right of a short-sighted glasses before reflected by a plane mirror. When an observer looks into the mirror, the reflected beam seems to diverge from I behind the mirror. What is the focal length of the short-sighted glasses?
A. 35 cm
B. 65 cm
C. 30 cm
D. 100 cm
25.


A student puts his glasses under sunlight as shown in the photo above. Two light spots are formed. Which of the following descriptions is/are correct?
(1) He is short-sighted.
(2) His glasses can be used as magnifying glasses.
(3) The light spots are the foci.
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
26.


A student put a rotating metal disc in between the poles of a permanent magnet as shown in the diagram above. Which of the following statements concerning the motion of the rotating metal disc is correct?
A. The metal disc first decelerates and then accelerates.
B. The metal disc accelerates.
C. The rotation speed of the metal disc remains constant.
D. The rotation of the metal disc stops.
27.


A student connects two identical light bulbs to a 1.5 V cell, as shown in the diagram above. The cell has an internal resistance of $0.5 \Omega$. Find the current flowing through each bulb, if each light bulb has a resistance of $10 \Omega$.
A. 0.15 A
B. 0.136 A
C. 0.286 A
D. 0.273 A
28.


In the above circuit, the two resistors are identical. If switch $S$ is closed, which of the following predictions are correct? Assume zero internal resistance for the batteries.
(1) The reading of the ammeter $A_{1}$ remains unchanged.
(2) The reading of the ammeter $A_{2}$ remains unchanged.
(3) The reading of the voltmeter remains unchanged.
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
29.


The diagram above shows a simple electromagnet. It is well known that ferromagnetic material are used to amplify the magnetic field created by the current in a coil. Which of the following elements are examples of ferromagnetic materials?
(1) nickel
(2) zinc
(3) cobalt
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
30.


The figure above shows an electron beam entering a uniform magnetic field. Which of the routes is correct? The direction of the magnetic field is pointing into the paper.
31.


In the diagram above, $X$ is an uncharged metal sphere and $Y$ is a positively-charged metal sphere, both of which rest on insulating rods. $Y$ is touched momentarily with $X$. Which of the following descriptions is correct?
A. The charges of sphere $Y$ remain unchanged.
B. The positively-charged protons of sphere $Y$ will move to the sphere $X$.
C. The neutral neutrons of sphere $X$ will move to the sphere $Y$.
D. The negatively-charged electrons of sphere $X$ will move to the sphere $Y$.

The figure above shows a lithium battery pack. What is the total amount of electric charges that can be stored in the battery according to the given information?
A. 23760 C
B. 6600 C
C. 95040 C
D. 9030 C
33.


The above diagram shows the cross-section of three parallel straight wires $P, Q$ and $R$ carrying equal currents 0.5 A flowing out of paper. What is the direction of the resultant force acting on $R$ by $P$ and $Q$ ?
A. $\quad \downarrow$
B. $\quad \uparrow$
C. $\leftarrow$
D. $\quad \rightarrow$

34．Which of the following are units of energy？
（1）kiloWatt hour（kWh）
（2）milliAmpere hour（mAh）
（3）electron Volt（eV）

A．（1）and（2）only
B．（1）and（3）only
C．（2）and（3）only
D．（1），（2）and（3）
35．LASIK（Laser－assisted in－situ keratomileusis 激光矯視手術）is presently the most commonly performed refractive surgery to correct short－sightedness，long－sightedness and astigmatism． Which of the following parts of an eye would doctor apply the laser to perform the surgery？

A．retina
B．lens
C．cornea
D．ciliary muscle

## Part B: Short Questions

Note: Show your solutions with steps and answers in Part B Answer Sheet.
1.


The Tung Chung Road linking between Tung Chung (the Lantau Island North) and the South of Lantau Island is very steep and curved. Vehicles usually run from high places down the hill and enter a corner at the lower end of the road. It is dangerous to turn the corners at a high speed.
(a) A cyclist is running downhill on Tung Chung Road. He accelerates from rest at ( $g \sin \theta$ ), where $g$ is $10 \mathrm{~m} \mathrm{~s}^{-2}$ and $\theta$ is the angle between the road and the horizontal. It takes him 12 s before he enters the corner. Assume the unbalanced force acting on the bicycle is $(m g \sin \theta)$.
(i) Suppose the slope of the road is 1 in 6 . Find the value of $\theta$.
(ii) Find the length of the steep road.
(iii) Find the cyclist's speed at the end of the sloped road.

(b) For safety reason, an "escape lane" is built at the end of the sloped road so that any vehicle can stop when the driver thinks the vehicle is too fast for entering the corner.
(i) Why is it dangerous to turn the round too fast?
(ii) State two features of the design of the escape lane.
2.

(a) Peter bought a red laser pointer in Sham Shui Po. He wants to find out the wavelength of the laser. A red laser beam is incident on a plane transmission grating with 270 slits per mm as shown above. A black paper screen is placed 90 cm under the grating on the floor. The photo below shows the pattern produced by the grating on the screen.

(i) Calculate the slit separation of the diffraction grating.
(1 mark)
(ii) Find the angular position of the second-order bright fringe.
(iii) Find the wavelength of the laser beam.

(b) Peter wants to find the slit separation of a Young's double-slit. He did so by replacing the plane transmission grating with a double slit, in the same set up shown at the top of this page. Besides, the distance between the screen and the double-slit is changed to 30 cm . The photo above shows the pattern produced by the double-slit. Find the slit separation of the double-slit.

