



## Secondary School Mathematics & Science Competition

# PHYSICS

Date : 05-05-2012

Total no. of pages : 15

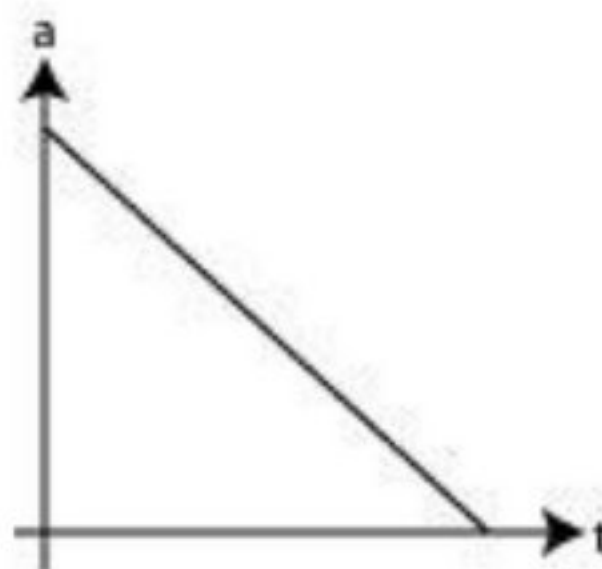
Time allowed : 11:30 am – 12:45 pm (1 hour 15 minutes)

1. Write your Name, School Name, Subject Name, Date and Student Number in the spaces provided on the answer sheet.
2. When told to open this book, you should check that all the questions are there. Look for the words '**END OF PAPER**' after the last question.
3. The paper is divided into two parts. Part A carries 68% and Part B 30%. Part A consists of thirty four Multiple Choice questions and Part B three short questions.
4. **ANSWER ALL QUESTIONS.** You should use an **HB** pencil to mark all your answers on the Answer Sheet. Wrong marks must be completely erased.
5. You should mark only **ONE** answer for each question in Section A. If you mark more than one answer, you will receive **NO MARKS** for that question.
6. **NO MARKS** will be deducted for wrong answers.
7. The diagrams in the paper are not necessarily drawn to scale.

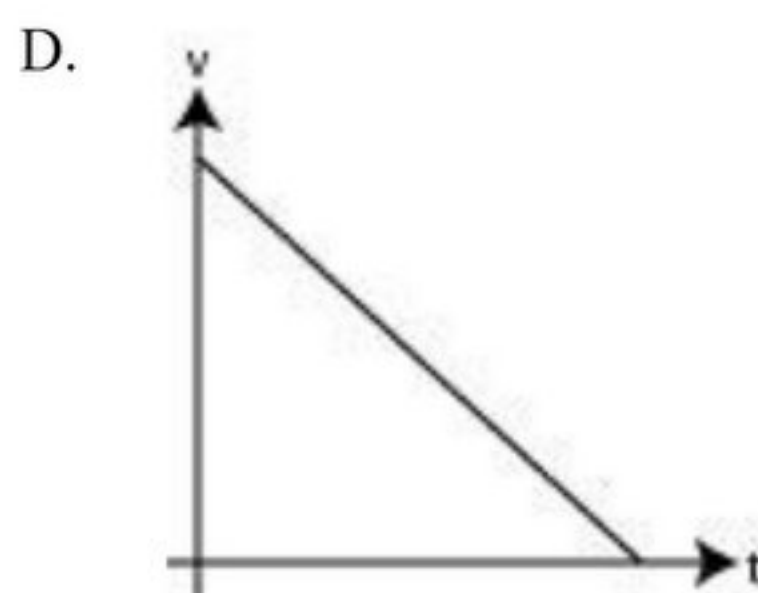
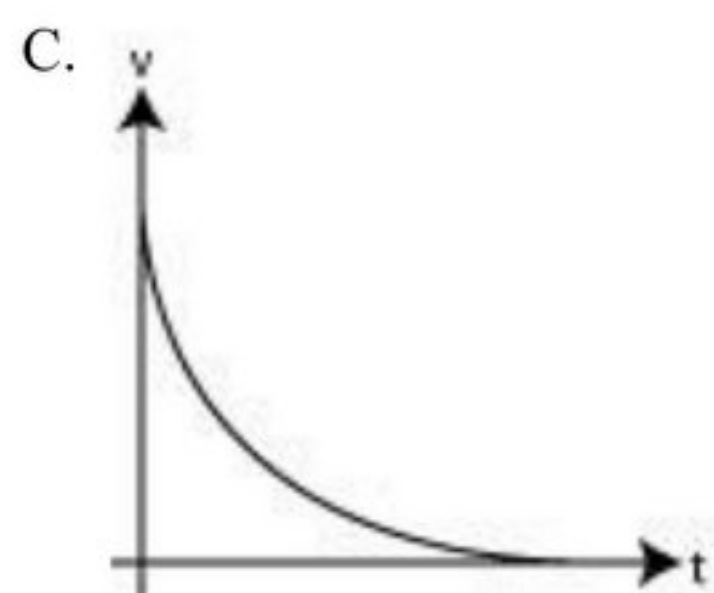
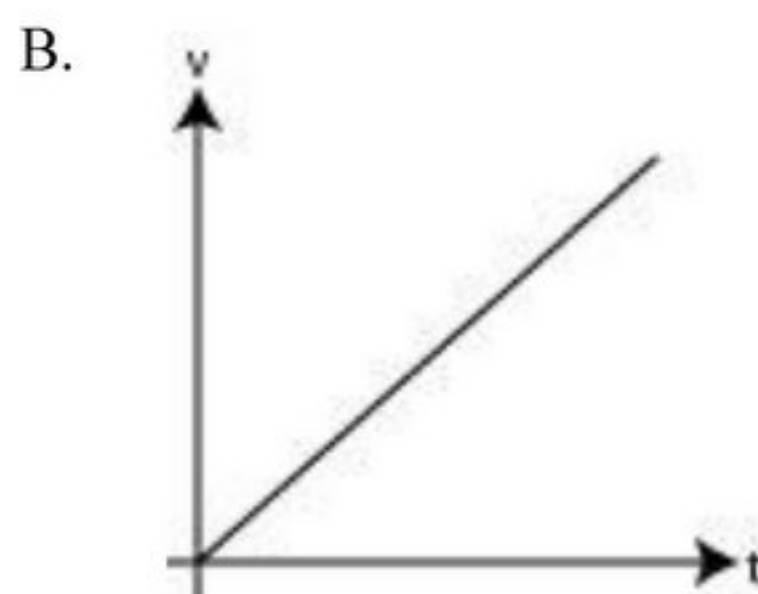
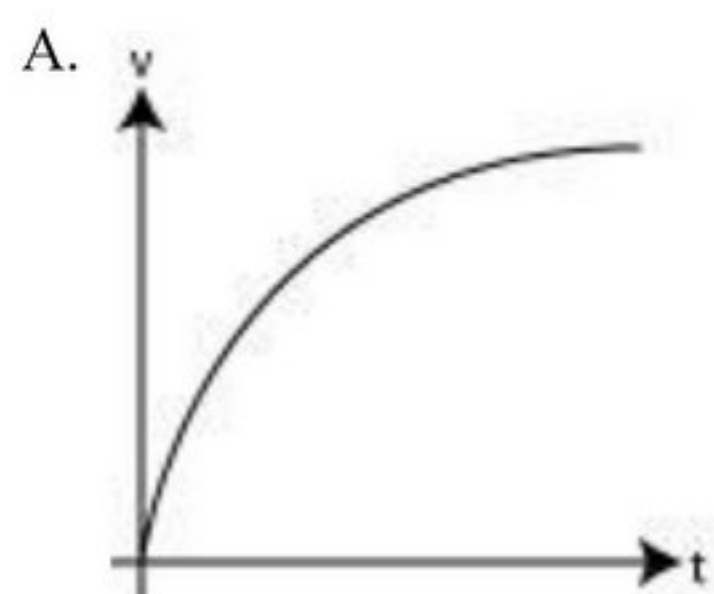
Assume: Gravitational acceleration on the surface of earth is  $10\text{ms}^{-2}$   
 Specific heat capacity of water  $4200\text{Jkg}^{-1}\text{C}^{-1}$   
 Specific latent heat of fusion of the ice is  $3.34 \times 10^5\text{Jkg}^{-1}$   
 Specific latent heat of vaporization of the water is  $2.26 \times 10^6\text{Jkg}^{-1}$   
 Universal gas constant is  $8.31\text{JK}^{-1}\text{mol}^{-1}$

### Part A : Multiple Choices

1. The acceleration – time graph of an object moving along a straight line is shown below.

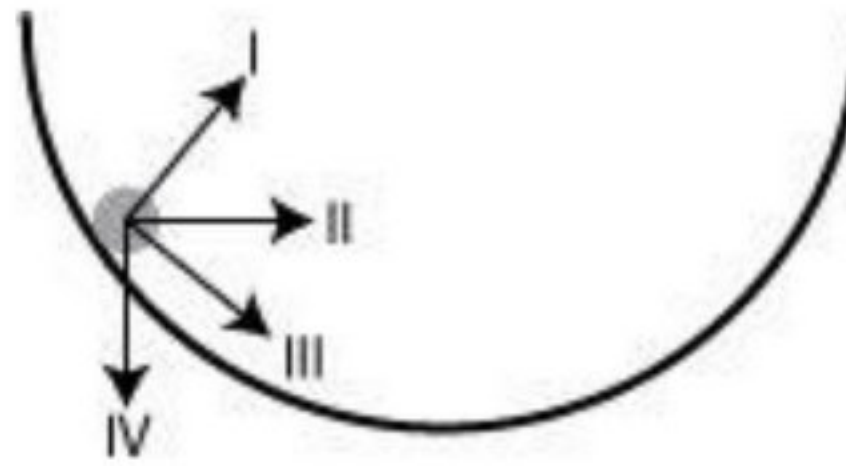


Which of the follow graphs best represents the relationship between the velocity and time of the object?

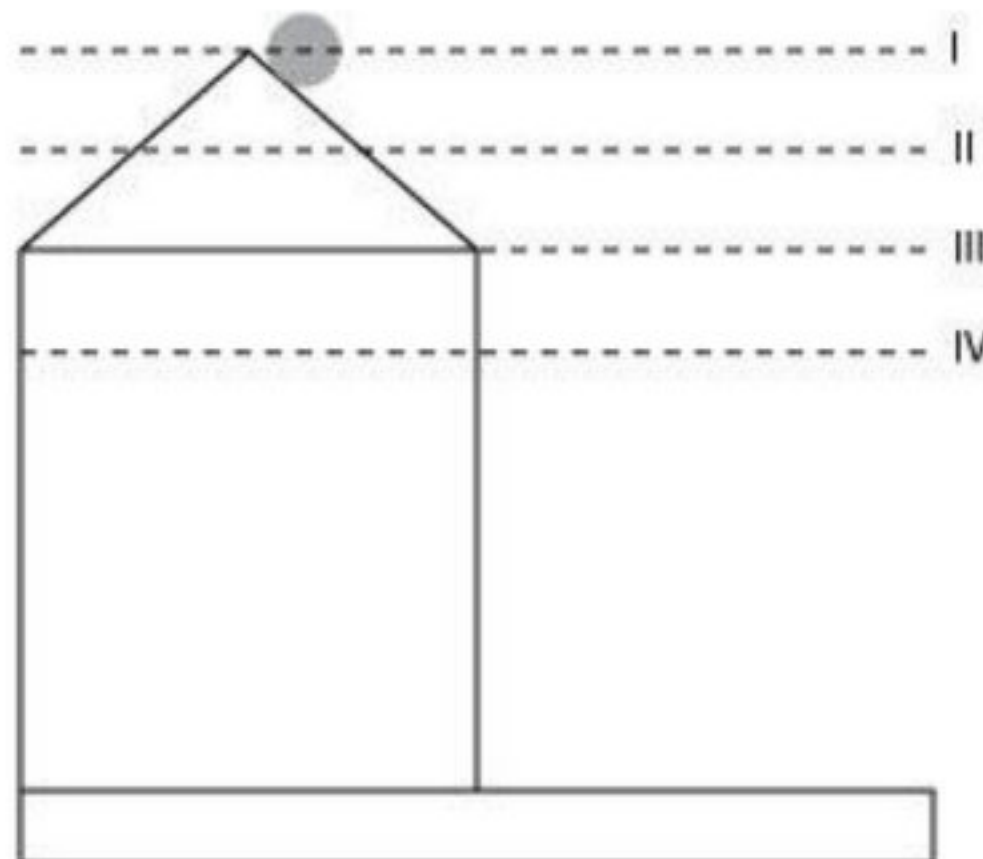




2. A small object is released from rest at the rim of a heavy, smooth semi-spherical bowl. Which of the following arrows best represents the direction of the net force acting on the object?

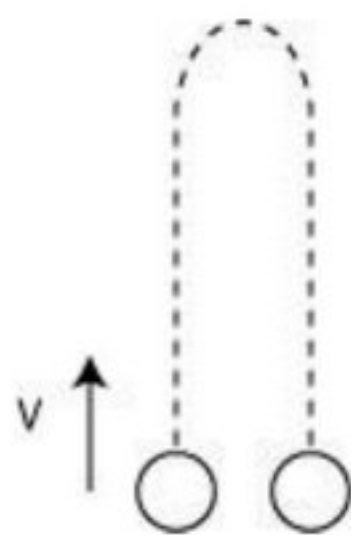


- A. I  
B. II  
C. III  
D. IV
3. An object slides down along the rough roof and then falls on the ground. If the collision between the object and the ground is perfectly elastic, which position best represent the maximum height reached by the object after the collision?

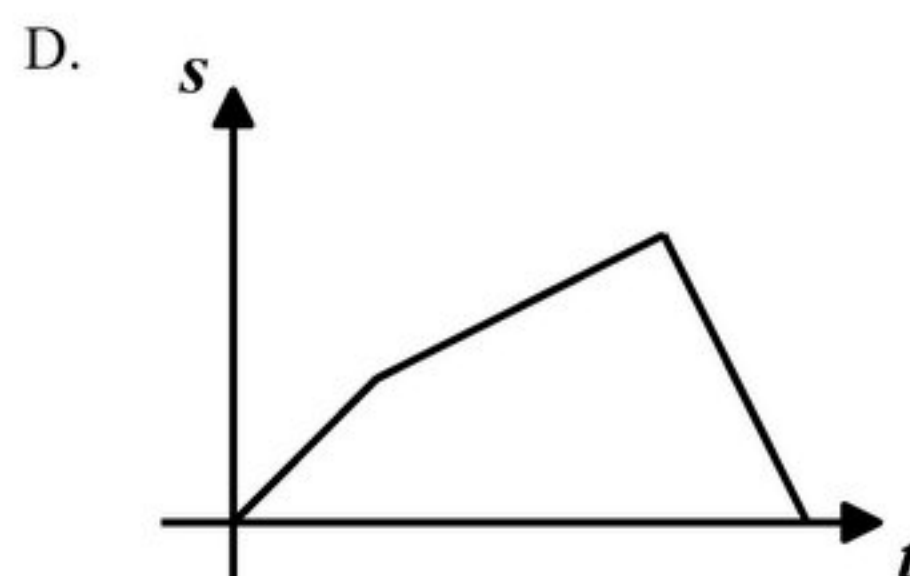
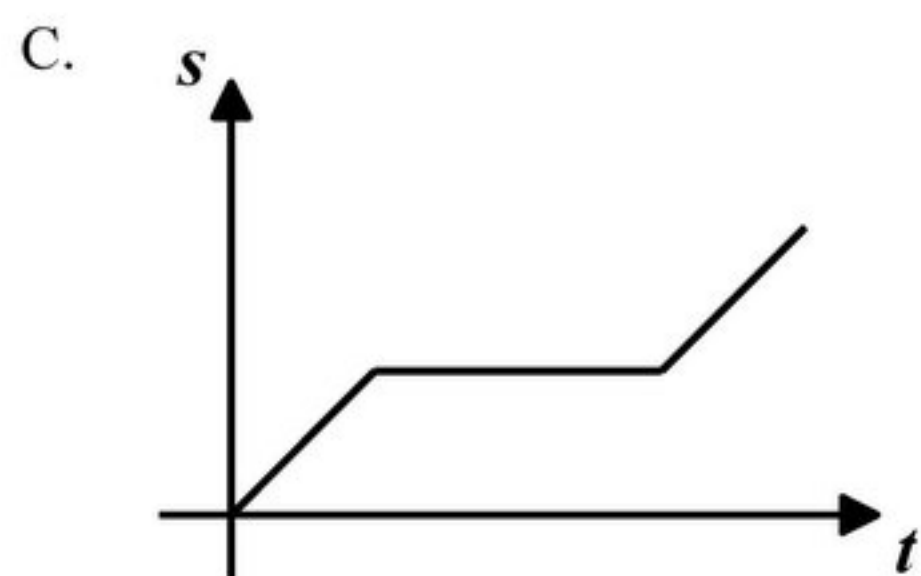
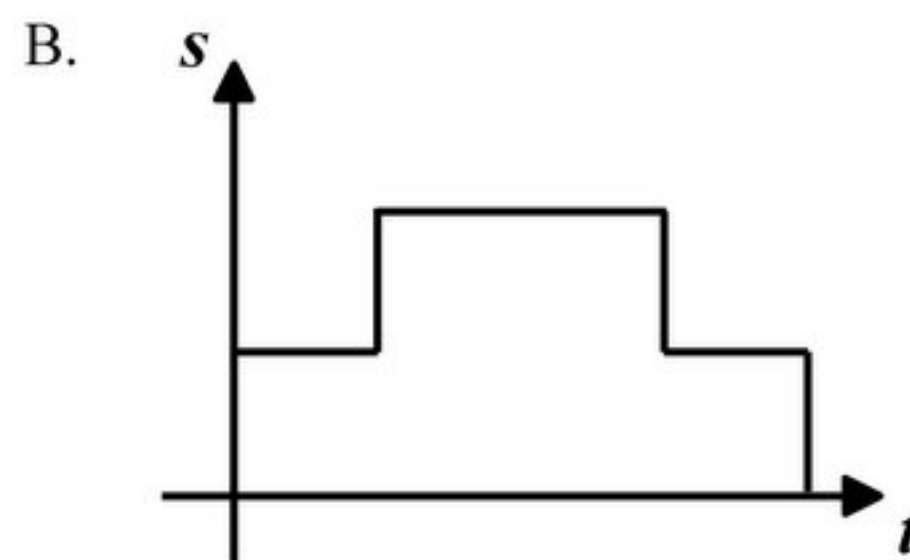
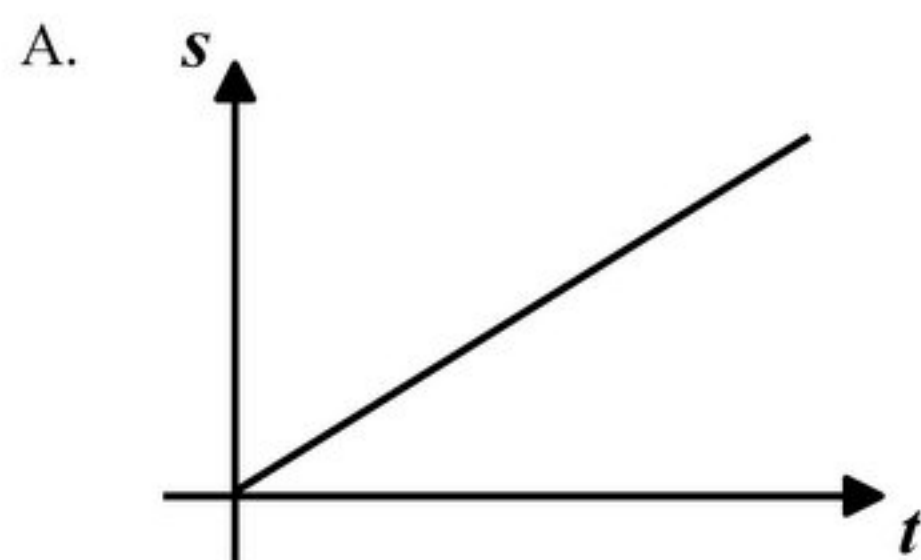
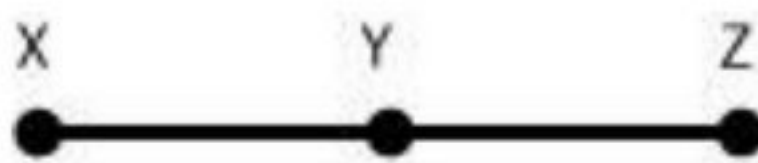


- A. I  
B. II  
C. III  
D. IV

4. An object with mass  $m$  is projected vertically upward with speed  $v$ . When it falls back to the original position, what is the change of the momentum of the object?

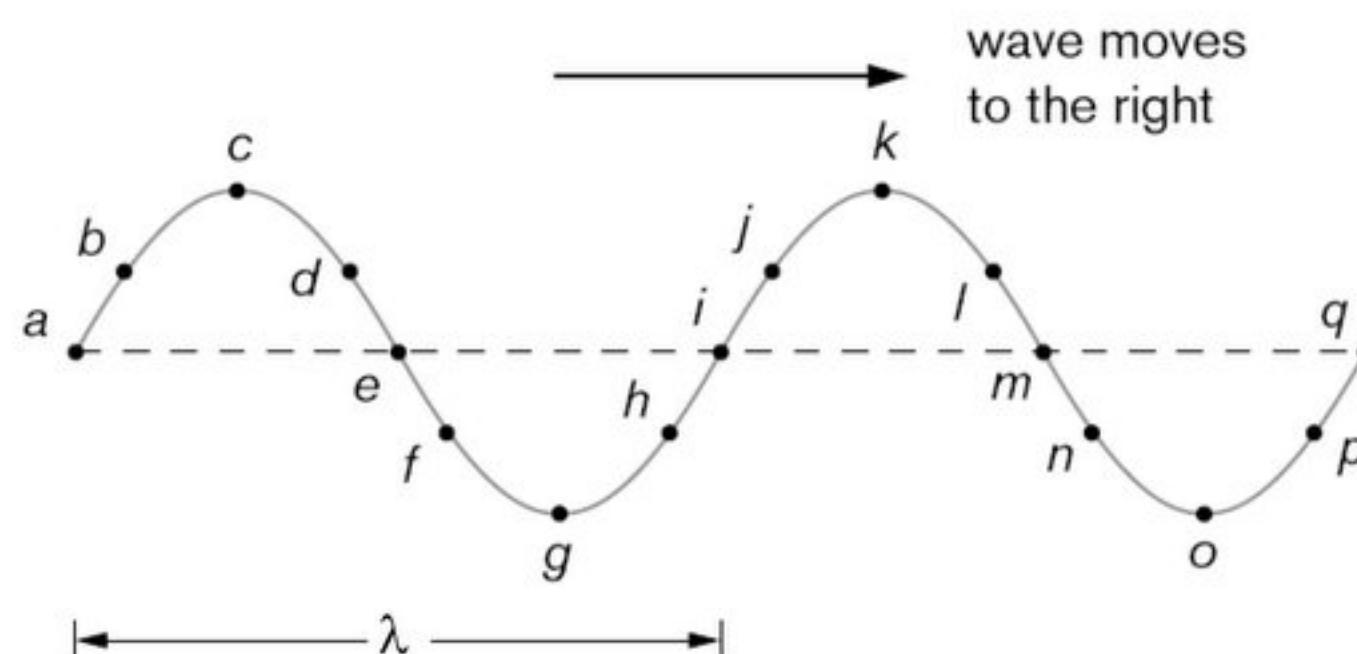


- A. 0                      B.  $mv$                       C.  $2mv$                       D.  $3mv$
5. Calvin walks along a straight path  $XYZ$  where  $XY = YZ$ . It takes him  $15s$ ,  $30s$ , and  $15s$  to travel through  $XY$ ,  $YZ$ , and  $ZX$  respectively. Which of the following graphs best represents the variation of displacement travelled against time?



6. Calvin is standing in a lift. The lift is initially at rest and then starts to move upward. Which of the following statement(s) is/are correct?
- (1) The gravitational force acting on Calvin has increased.
  - (2) The normal reaction acting on Calvin has increased.
  - (3) The weight of Calvin has increased.
- A. (1) only  
B. (3) only  
C. (1) and (2) only  
D. (2) and (3) only
7. In a racing competition, a racing car is travelling at  $50\text{ms}^{-1}$  along a straight road. However, in order to avoid an accident, the brakes are applied and it slows down uniformly to  $20\text{ms}^{-1}$  in 3s. Determine the distance travelled in the 3<sup>rd</sup> second since the brakes are applied.
- A. 10m  
B. 25m  
C. 80m  
D. 105m
8. A block of mass 8kg is placed in a lift. Find the normal reaction force acting on the block by the floor of the lift, if the lift is moving upwards with a uniform velocity of  $8\text{ms}^{-1}$ . (Acceleration due to gravity is  $10\text{ms}^{-2}$ )
- A. 64N  
B. 80N  
C. 88N  
D. 144N

9. The figure below shows some particles on a transverse wave.



Which of the following statement(s) is/are correct?

- (1) Particles *c* and *k* vibrate in phase.
- (2) Particles *a* and *m* vibrate in antiphase.
- (3) Particles *c* and *g* vibrate in antiphase.

- A. (1) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

10. The waves produced by two coherent sources must have

- (1) the same frequency.
- (2) the same amplitude.
- (3) a constant phase difference.

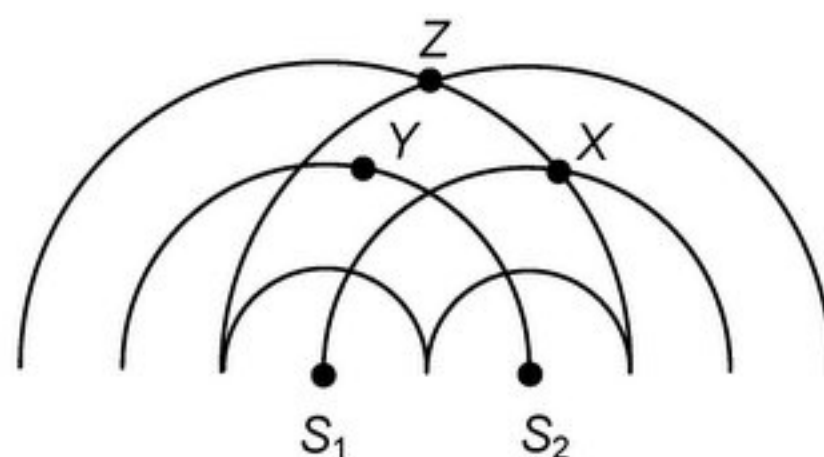
- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

11. A spring with one end fixed to the wall is stretched to 4 m long. The other end of the spring is vibrated to produce stationary wave patterns. The minimum frequency of vibration to produce a stationary wave pattern on the spring is 5 Hz. What is the speed of wave in the spring?

- A.  $10 \text{ m s}^{-1}$
- B.  $20 \text{ m s}^{-1}$
- C.  $40 \text{ m s}^{-1}$
- D.  $80 \text{ m s}^{-1}$

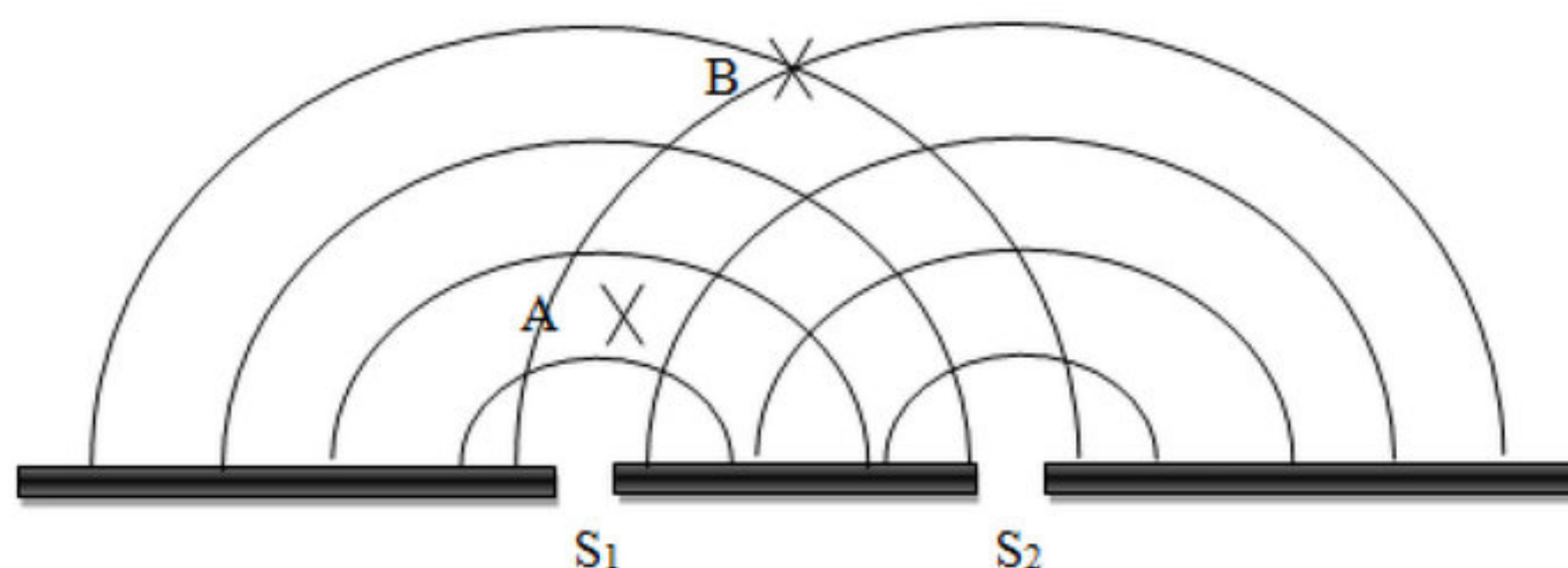


12. Dippers,  $S_1$  and  $S_2$ , produce circular wavefronts in a ripple tank. Which of the following statement(s) is/are correct?



- (1) Constructive interference occurs at  $X$ ,  $Y$  and  $Z$ .
  - (2) Amplitudes of the wave at  $X$  and  $Y$  are always zero.
  - (3) More nodal and antinodal lines can be observed when the frequency of the dippers increases.
- A. (3) only
- B. (1) and (2) only
- C. (2) and (3) only
- D. (1), (2) and (3)
13. When a monochromatic light of wavelength 500 nm is directed perpendicularly to a diffraction grating, the second order bright fringe is formed at an angle  $30^\circ$  to the normal of the grating. What is the number of lines per cm of the grating?
- A. 100
- B. 5000
- C. 10 000
- D. 500 000
14. Which of the following statements about light and sound is correct?
- A. Both light and sound are transverse waves.
- B. Both light and sound can travel in a vacuum.
- C. Both light and sound travel slower in water than in air.
- D. Both light and sound undergo refraction when travelling from one medium into another at an angle.

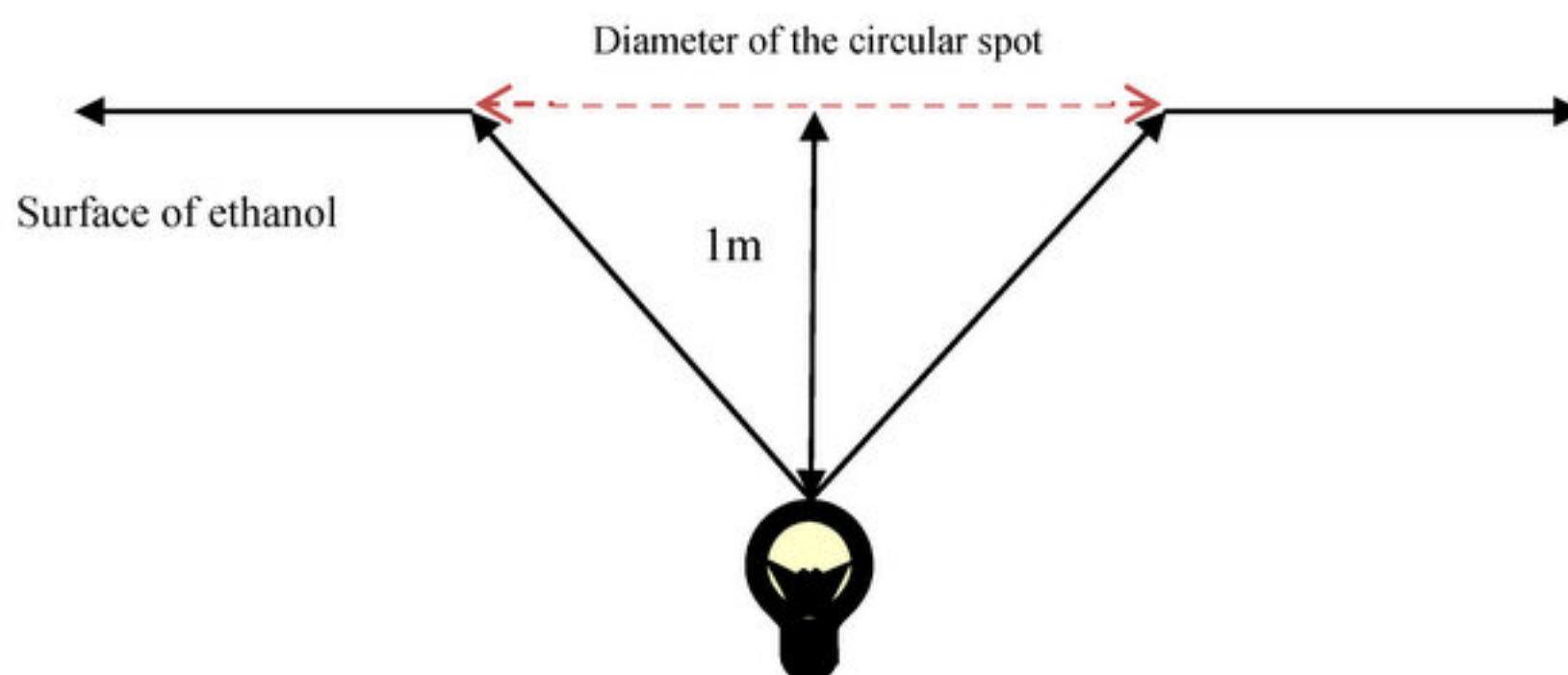
15. The diagram below shows the positions of successive crests of water ripples generated by two vibrating sources  $S_1$  and  $S_2$  attached to the same vibrating arm in a horizontal plane. If the path difference between  $S_1A$  and  $S_2A$  is  $0.6\text{m}$ , and the wave takes  $2\text{s}$  to travel from  $S_2$  to point B, calculate the frequency of the vibrating sources.



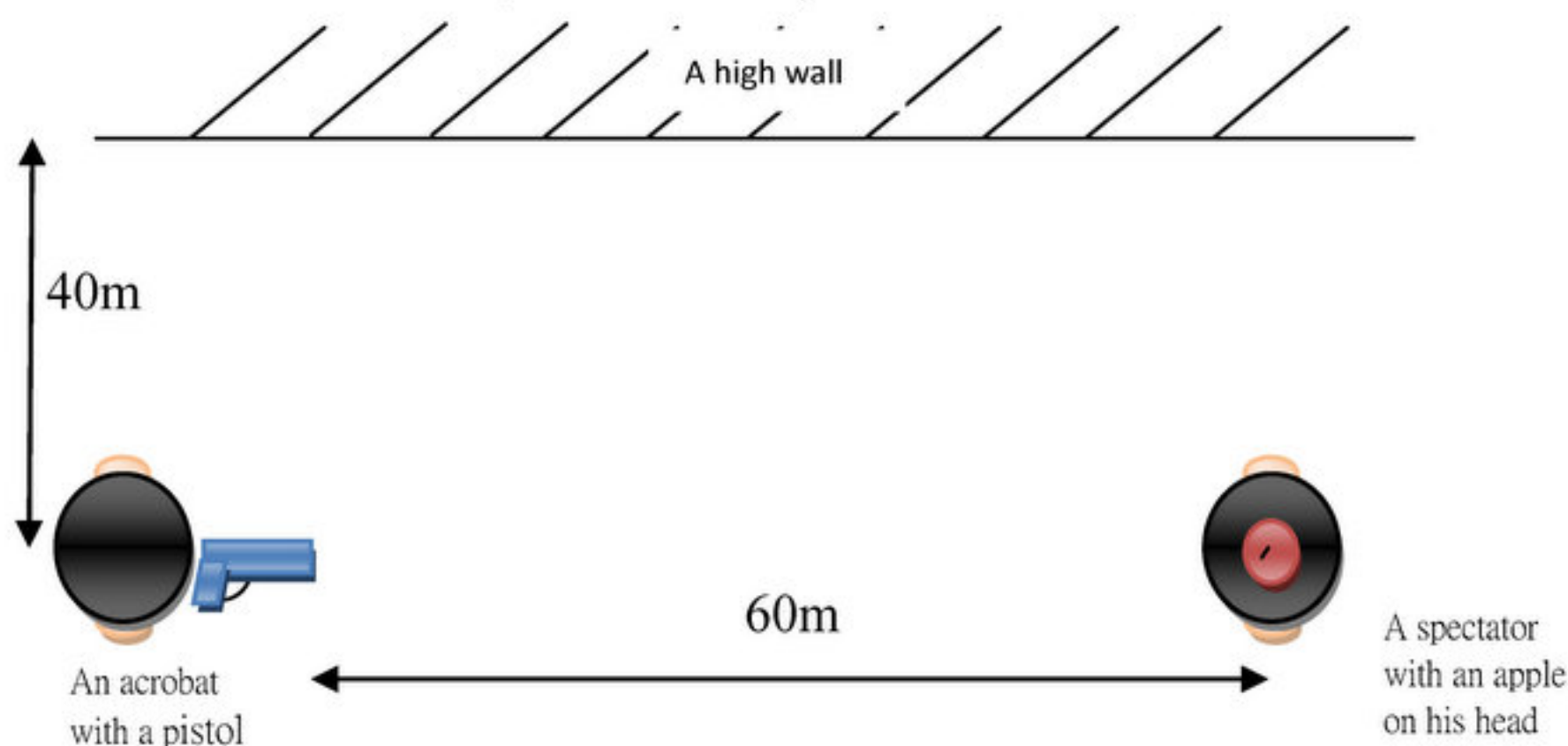
- A.  $1.2\text{ Hz}$   
 B.  $1.8\text{ Hz}$   
 C.  $2.0\text{ Hz}$   
 D.  $4.0\text{ Hz}$
16. Determine the nature of the image for an object, which is placed  $10\text{cm}$  in front of a divergent lens of focal length  $15\text{ cm}$ .
- A. virtual, erect and diminished image  
 B. virtual, inverted and diminished image  
 C. real, inverted and magnified image  
 D. real, erect and magnified image
17. A man facing a vertical cliff finds that the interval between a sound made by him and its echo is  $1\text{s}$ . Then he walks  $255\text{m}$  away from the cliff and finds that the interval is now  $2.5\text{s}$ . Determine the velocity of sound in air.
- A.  $170\text{ms}^{-1}$   
 B.  $320\text{ms}^{-1}$   
 C.  $340\text{ms}^{-1}$   
 D.  $383\text{ms}^{-1}$



18. A small light bulb is lowered 1m below the surface of a large tank of ethanol. Calculate the diameter of the circular spot of light as seen on the surface of the ethanol, given the refractive index of ethanol is 1.36.



- A. 1.08m  
 B. 1.47m  
 C. 2.08m  
 D. 2.17m
19. An acrobat holds a pistol towards a spectator, who has an apple placed on his head. The two men stand facing each other and are 60m apart, on one side of a high wall and at the same perpendicular distance of 40m from it as shown below. Now the acrobat fires the pistol to hit the apple and the spectator hears two sounds from the pistol. Calculate the time differences between these two sounds, if the velocity of sound in air is  $340\text{ms}^{-1}$ .

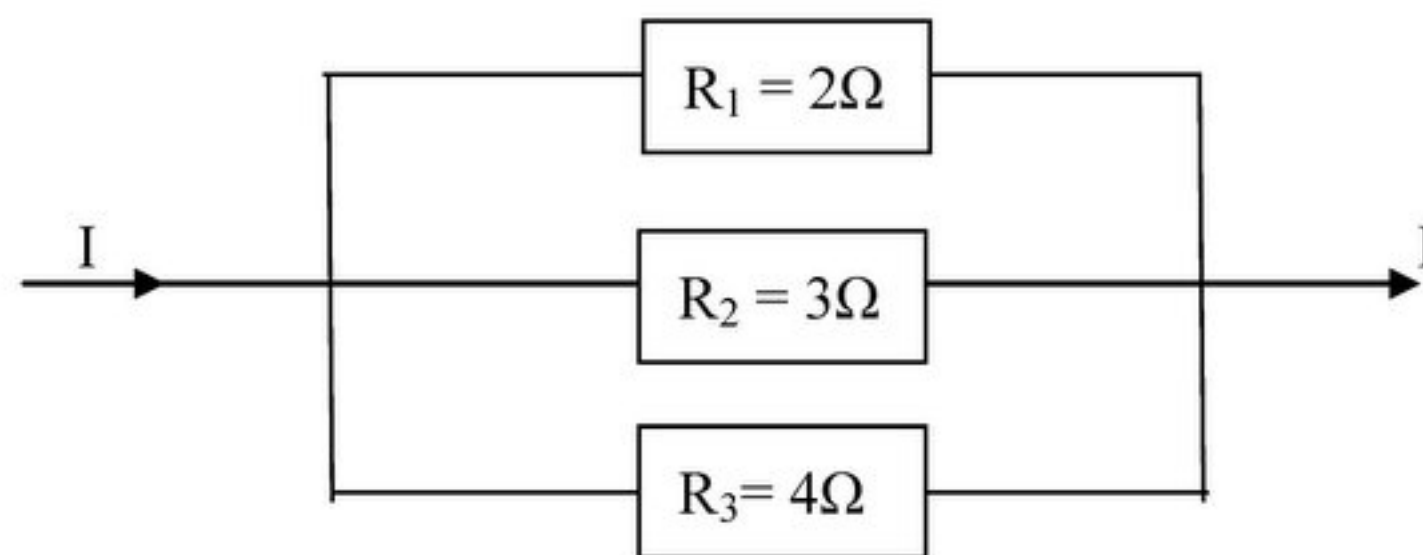


- A. 0.103s  
 B. 0.118s  
 C. 0.176s  
 D. 0.294s

20. A transformer has an input voltage of 100V and an output voltage of 200V if it is under normal operation. Now, if a steady direct current of 8A passes through the primary coil, determine the output current of the transformer.

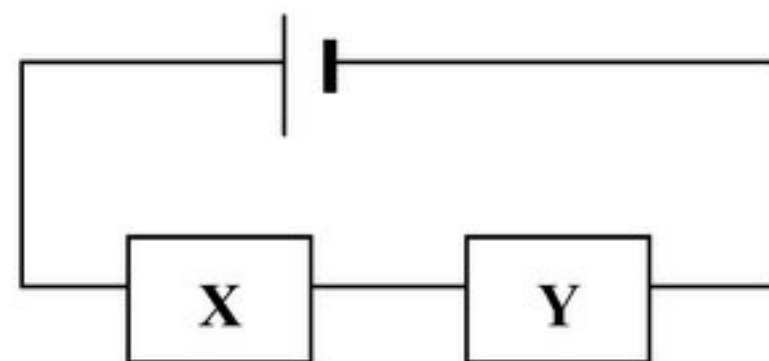
A. 0A  
 B. 3.6A  
 C. 4A  
 D. 4.4A

21. The diagram below shows a simple parallel circuit with a steady current  $I$ . Determine the power ratio  $P_1 : P_2 : P_3$  liberated by the resistors  $R_1$ ,  $R_2$ ,  $R_3$ , where  $P_1$ ,  $P_2$  and  $P_3$  are the powers of resistors  $R_1$ ,  $R_2$  and  $R_3$ , respectively.



A. 2:3:4  
 B. 4:3:2  
 C. 7:6:5  
 D. 6:4:3

22. The diagram below shows a circuit with two identical resistors **X** and **Y**. An ideal voltmeter detects the potential difference across resistor **X** is  $V$ . Another resistor **Z**, also with same resistance as **X** and **Y**, is added in parallel with resistor **X**. What is the new potential difference across resistor **X**?



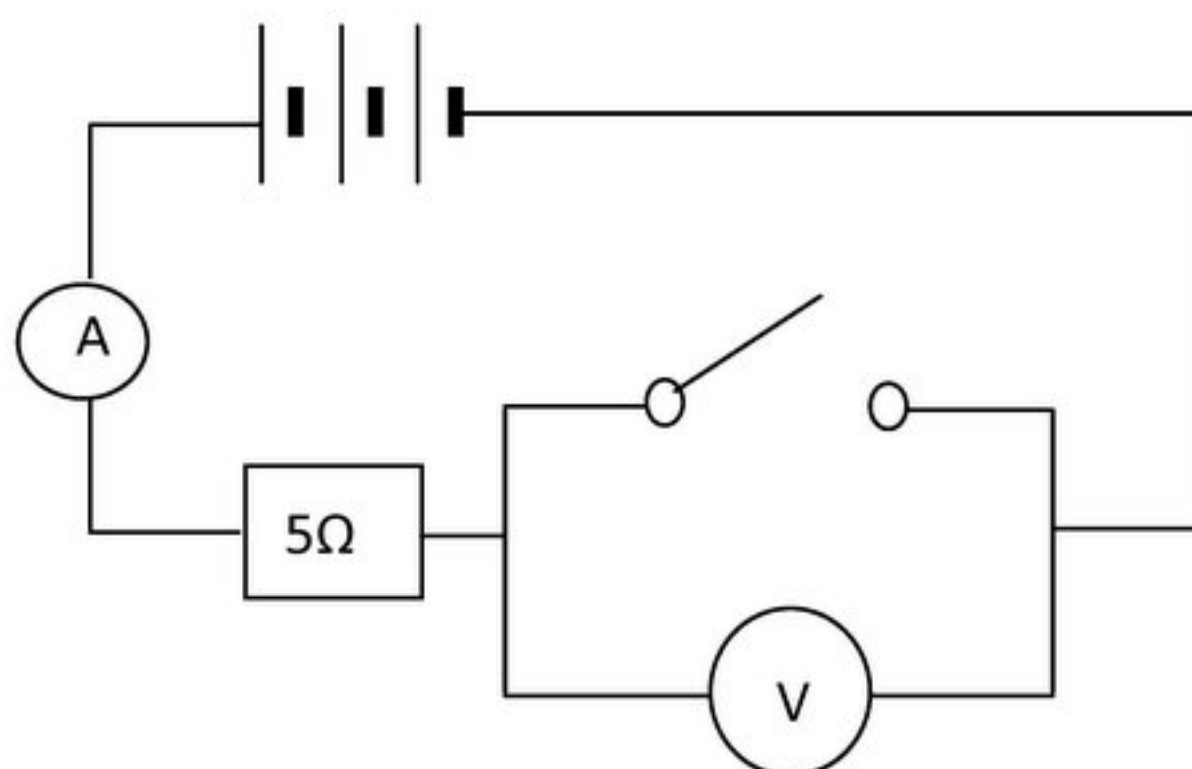
A.  $V$                       B.  $\frac{V}{2}$                       C.  $\frac{2V}{3}$                       D.  $\frac{3V}{2}$



23. A copper wire with length  $L$  and diameter  $d$  has a resistance of  $R$ . What is the resistance of the copper wire if the length is halved and the diameter is doubled to the original wire?

- A.  $R$
- B.  $\frac{R}{2}$
- C.  $\frac{R}{4}$
- D.  $\frac{R}{8}$

24. Referring to the circuit diagram shown below, when the switch is opened, the ideal voltmeter reads 10V. What would be the reading of ideal ammeter and voltmeter if the switch is closed?



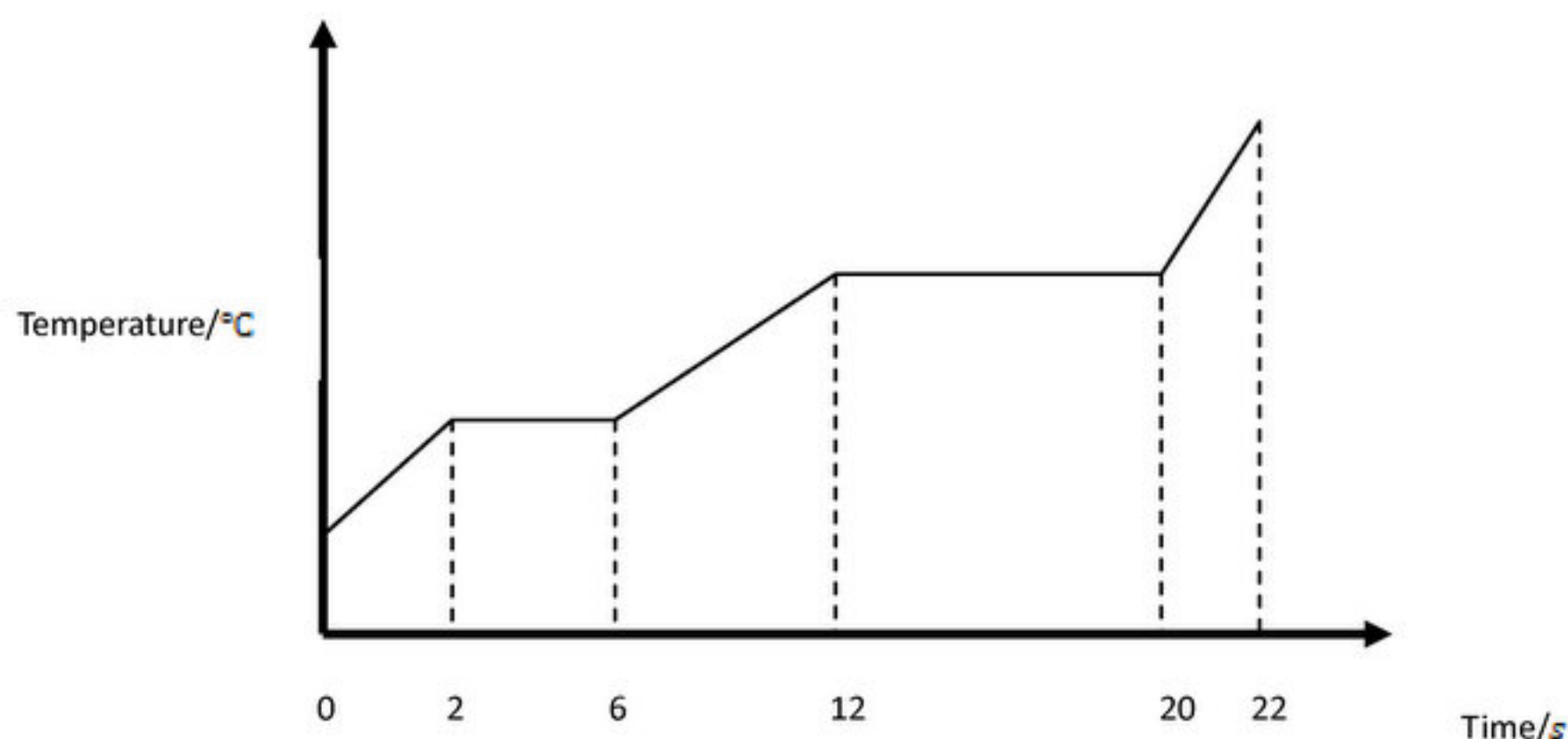
- |    | Ammeter<br>reading | Voltmeter<br>reading |
|----|--------------------|----------------------|
| A. | 0A                 | 10V                  |
| B. | 2A                 | 5V                   |
| C. | 5A                 | 5V                   |
| D. | 2A                 | 0V                   |

25. Water at  $26^{\circ}\text{C}$  flows through the pipe into a solar heater at a rate of  $0.07 \text{ kg min}^{-1}$ , while the power supplied by the heater is 300W. Determine the final temperature of water which flows out of the solar heater. Specific heat capacity of water is  $4200 \text{ J kg}^{-1} \text{ }^{\circ}\text{C}^{-1}$ .

- A.  $27^{\circ}\text{C}$
- B.  $61^{\circ}\text{C}$
- C.  $87^{\circ}\text{C}$
- D.  $96^{\circ}\text{C}$



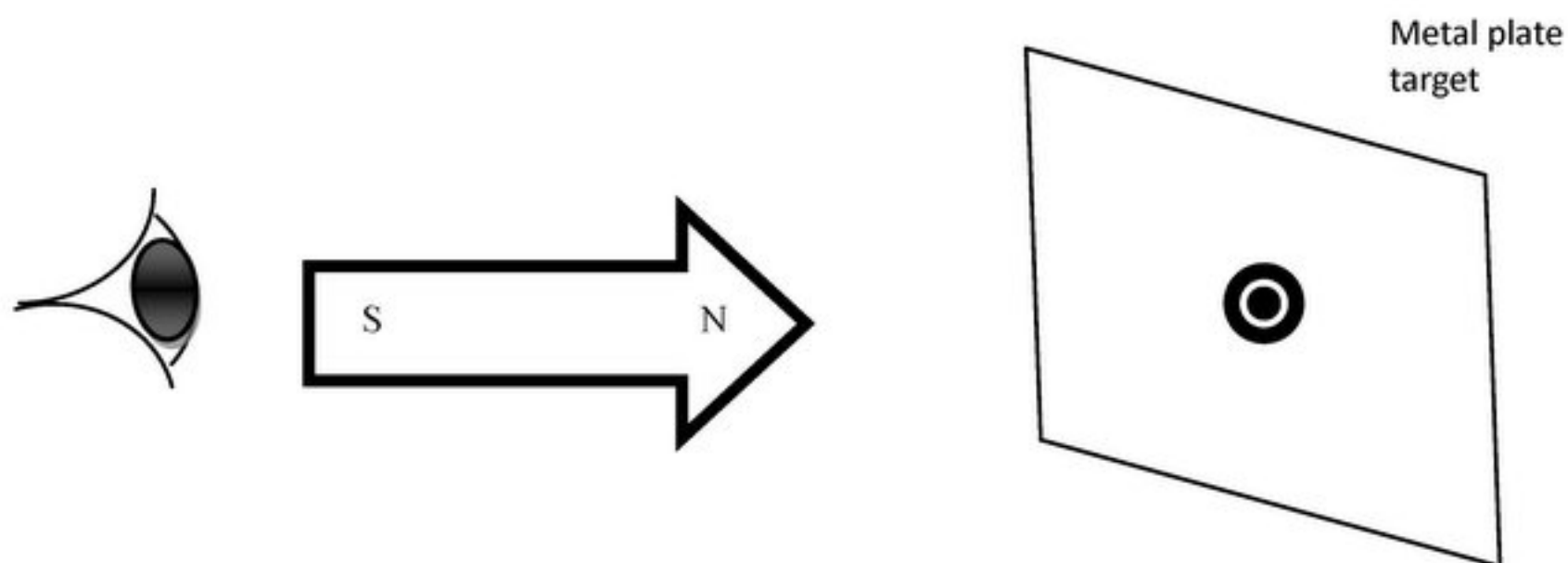
26. The diagram below shows temperature-time graph of a substance with mass 2kg, which is heated from solid state to vapour state by a constant 300W power supply. What is the energy supplied by the heater from the pure liquid state until it totally changed into the vapour state?



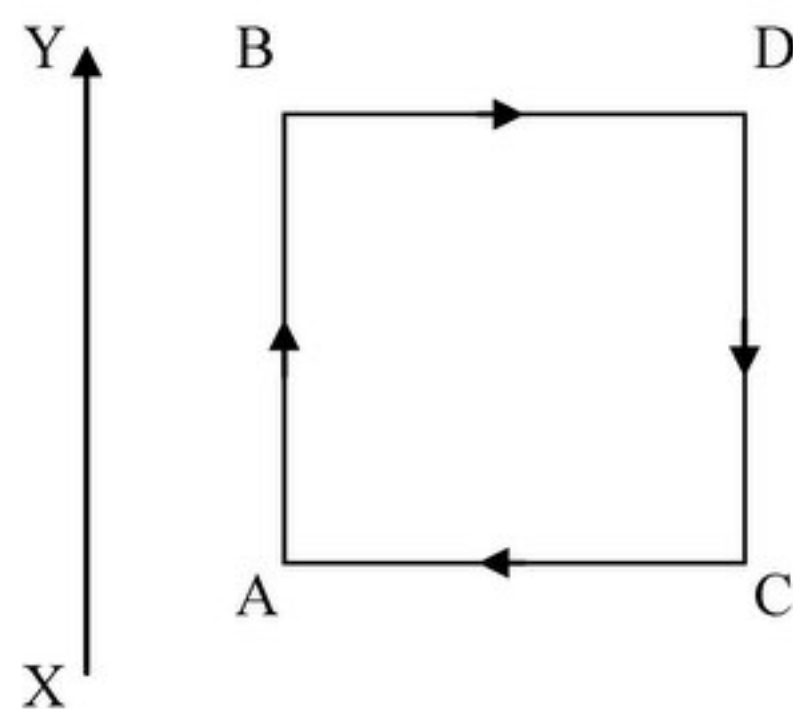
- A. 4200J  
 B. 4800J  
 C. 6000J  
 D. 6600J
27. Which of the following statements about the internal energy and temperature of two objects is/are correct?
- (1) The object with particles of larger average kinetic energy must have a higher temperature.
  - (2) The object with larger internal energy must have a higher temperature.
  - (3) When the objects are in contact, heat is transferred from the one with larger internal energy to the other.
- A. (1) only  
 B. (2) only  
 C. (1) and (3) only  
 D. (2) and (3) only
28. A metal block of mass 2 kg is supplied with 24 kJ of heat. Its temperature rises from 25 °C to 45 °C. What is the heat capacity of the block?
- A. 20 J °C<sup>-1</sup>  
 B. 600 J °C<sup>-1</sup>  
 C. 1200 J °C<sup>-1</sup>  
 D. 12 000 J °C<sup>-1</sup>

29. Which of the following quantities should be used for finding out the energy released by the steam at 100 °C when it is converted into water at 0 °C?
- (1) Heat capacity of steam
  - (2) Latent heat of vaporization of water
  - (3) Latent heat of fusion of ice
- A. (1) only  
B. (2) only  
C. (1) and (2) only  
D. (1), (2) and (3)
30. Why is the heat exchanger at the back of a refrigerator usually black in colour?
- A. Materials coloured black lose more energy by convection.  
B. Materials coloured black lose more energy by evaporation.  
C. Materials coloured black conduct energy better.  
D. Materials coloured black radiate energy better.
31. Which of the following descriptions about the random motion of gas molecules must be correct?
- (1) It is more vigorous at high temperature.
  - (2) It is more vigorous at high pressure.
  - (3) It is more vigorous in a small volume.
- A. (1) only  
B. (2) only  
C. (1) and (2) only  
D. (2) and (3) only
32. In the kinetic theory of ideal gases, which of the following assumptions introduces the factor of  $\frac{1}{3}$  to the equation  $pV = \frac{1}{3}Nm\overline{c^2}$ ?
- A. All collisions of molecules are elastic.  
B. The size of each molecule can be neglected.  
C. All molecules are in random motion.  
D. Intermolecular forces are negligible.

33. An archer is shooting an arrow-shaped permanent magnet towards a metal plate target as shown below. Determine the direction of the eddy currents which is produced in the target plate.



- A. Clockwise  
 B. Anti-clockwise  
 C. Pointing into the metal plate  
 D. Pointing out of the metal plate
34. A long straight wire XY carries a direct current flowing from X to Y. A rectangular coil ABCD whose edges are parallel to the wire carries a current in the clockwise direction as shown below. State the direction of the resultant force exerted on the rectangular coil ABCD.



- A. No resultant force  
 B. Left  
 C. Right  
 D. Upwards

- END OF PART A -



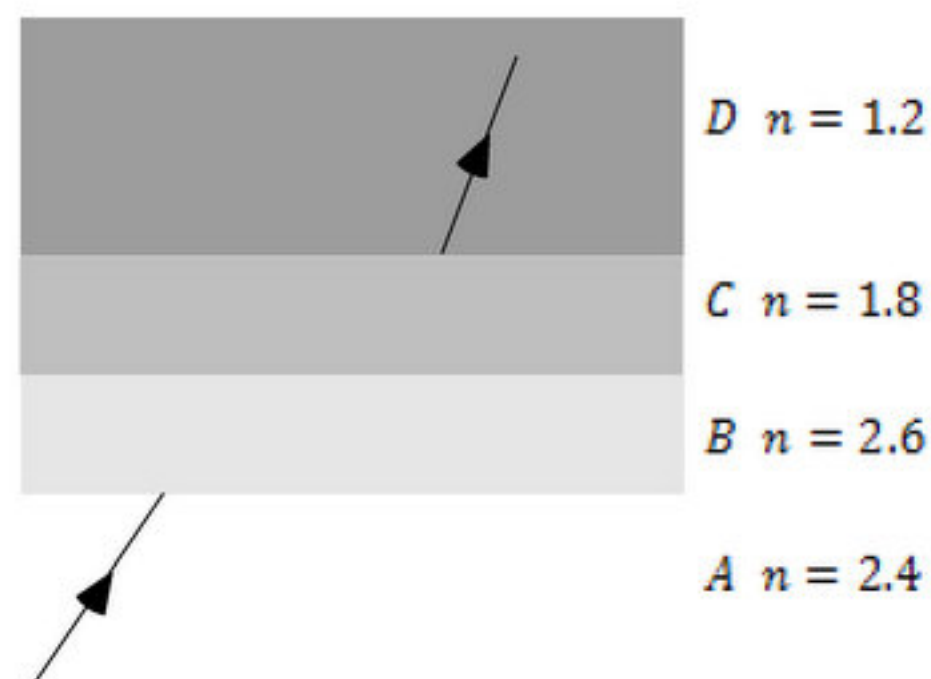
**Part B: Short Question****Note: Show your solutions with steps and answers in Part B Answer Sheet.**

1. 2kg of apple juice at 25°C is poured into a thermo flask containing ice cubes at 0°C. After a few minutes when all the ice cubes are melted, the mixture is found to be at 10°C. Determine the mass of the ice cubes originally in the flask.

(Specific heat capacity of apple juice is  $4000\text{Jkg}^{-1}\text{°C}^{-1}$  and the specific latent heat of ice is  $334000\text{Jkg}^{-1}$ ).

The original mass of the ice cubes  $M =$  \_\_\_\_\_

2.



There are four different media  $A$ ,  $B$ ,  $C$  and  $D$  with refractive index 2.4, 2.6, 1.8 and 1.2 respectively. If a light ray incident from medium  $A$  to medium  $B$  at an angle of incidence  $30^\circ$ , what is the refracted angle of light from  $C$  to  $D$ .

3. A body falls freely from rest at a height  $H\text{ m}$  from the ground. In the last two seconds ( $2\text{ s}$ ) of its journey it falls a distance  $\frac{H}{3}$ . Find  $H$ .

$H =$  \_\_\_\_\_

**- END OF PAPER -**