Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Thursday 28 April 2022 (morning)

45 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

2222 – 6510

15 pages

1. What is the order of magnitude of the wavelength of visible light?

A. 10^{-10} m

B. 10^{-7} m

C. 10^{-4} m

D. 10^{-1} m

2. The magnitude of the resultant of two forces acting on a body is 12 N. Which pair of forces acting on the body can combine to produce this resultant?

A. 1 N and 2 N

B. 1 N and 14 N

C. 5 N and 6 N

D. 6 N and 7 N

3. A student measures the time for 20 oscillations of a pendulum. The experiment is repeated four times. The measurements are:

10.45 s

10.30 s

10.70 s

10.55 s

What is the best estimate of the uncertainty in the average time for 20 oscillations?

A. 0.01 s

B. 0.05 s

C. 0.2 s

D. 0.5 s

4. A block moving with initial speed *v* is brought to rest, after travelling a distance *d*, by a frictional force f. A second identical block moving with initial speed *u* is brought to rest in the same distance *d* by a frictional force $\frac{f}{2}$. What is *u*?

A. v

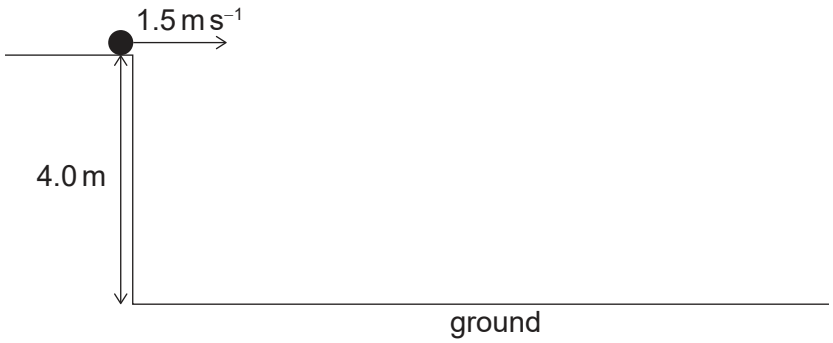
B. $\frac{v}{\sqrt{2}}$

C. $\frac{v}{2}$

D. $\frac{v}{4}$

5. A stone is kicked horizontally at a speed of $1.5\,\text{m}\,\text{s}^{-1}$ from the edge of a cliff on one of Jupiter's moons. It hits the ground 2.0 s later. The height of the cliff is 4.0 m.
Air resistance is negligible.

What is the magnitude of the displacement of the stone?



A. 7.0 m

B. 5.0 m

C. 4.0 m

D. 3.0 m

6. Which of the formulae represents Newton's second law?

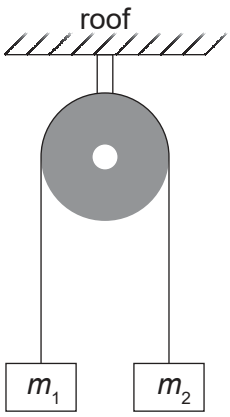
A. $\frac{\text{mass}}{\text{volume}}$

B. $\frac{\text{work}}{\text{displacement}}$

C. $\frac{\text{change of momentum}}{\text{time}}$

D. pressure × area

7. Two masses m_1 and m_2 are connected by a string over a frictionless pulley of negligible mass. The masses are released from rest. Air resistance is negligible.



Mass m_2 accelerates downwards at $\frac{g}{2}$. What is $\frac{m_1}{m_2}$?

A. $\frac{1}{3}$

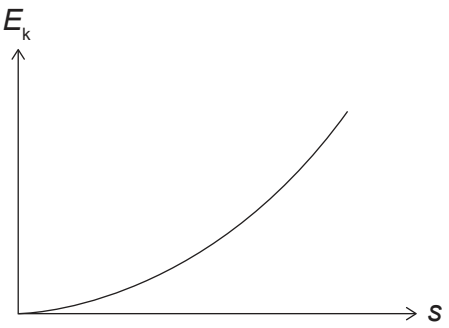
B. $\frac{1}{2}$

C. 2

D. 3

8. A cart travels from rest along a horizontal surface with a constant acceleration. What is the variation of the kinetic energy E_k of the cart with its distance s travelled? Air resistance is negligible.

A.



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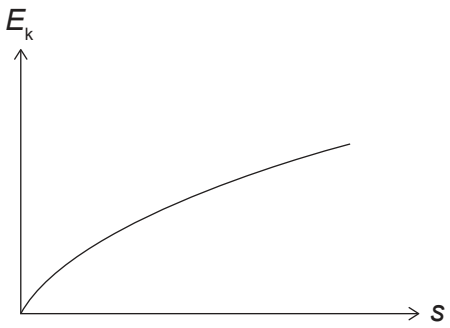

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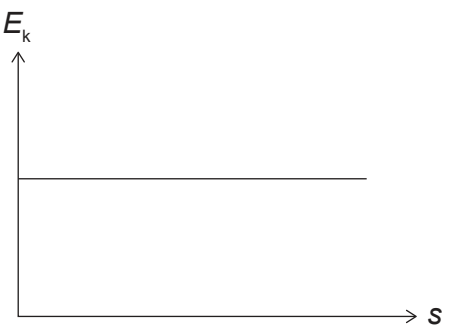

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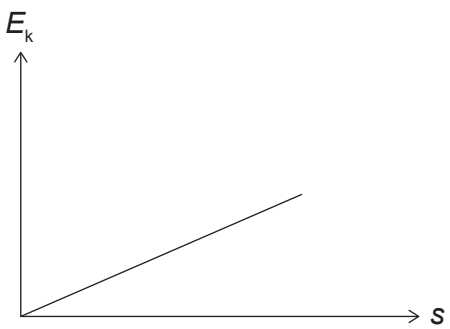


9. Two trolleys of equal mass travel in opposite directions as shown.

The trolleys collide head-on and stick together.

What is their velocity after the collision?

A. $1\,m\,s^{-1}$

B. $2\,m\,s^{-1}$

C. $5\,m\,s^{-1}$

D. $10\,m\,s^{-1}$

10. A driver uses the brakes on a car to descend a hill at constant speed. What is correct about the internal energy of the brake discs?

A. The internal energy increases.

B. The internal energy decreases.

C. There is no change in the internal energy.

D. The internal energy is zero.

11. Two blocks, X and Y, are placed in contact with each other. Data for the blocks are provided.

	Block X	**Block Y**
Initial temperature / °C	20	80
Final temperature / °C	60	60
Specific heat capacity	$2c$	c

X has a mass m. What is the mass of Y?

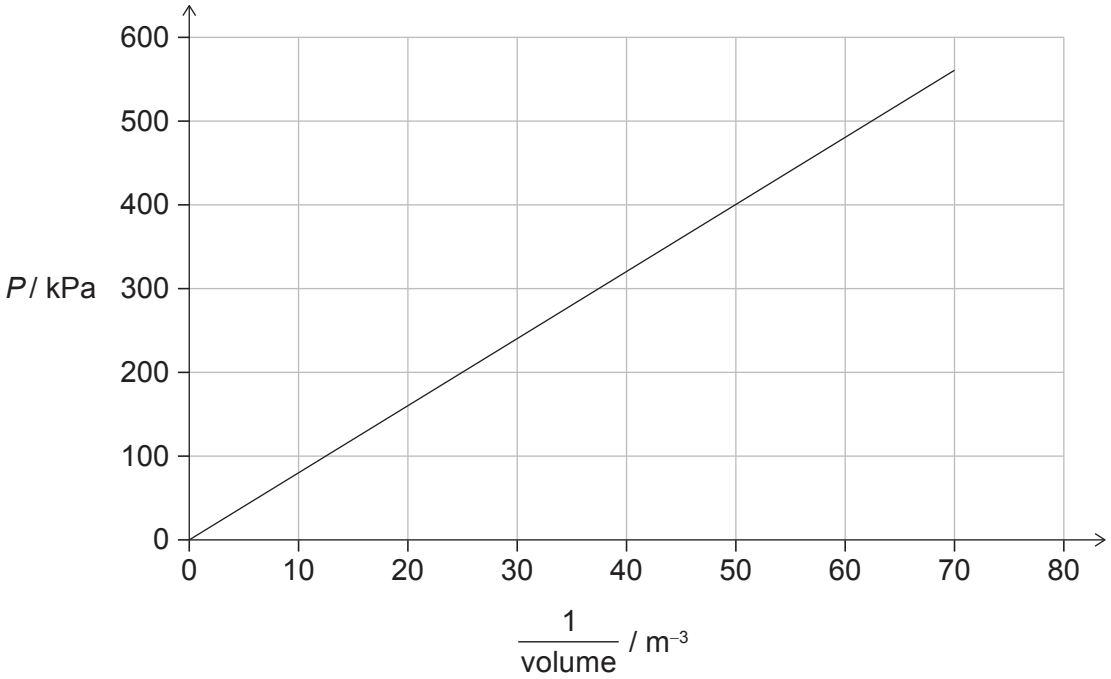
A. $\frac{m}{4}$

B. m

C. $4m$

D. $6m$

12. An ideal gas is maintained at a temperature of 100 K. The variation of the pressure P and $\frac{1}{\text{volume}}$ of the gas is shown.



What is the quantity of the gas?

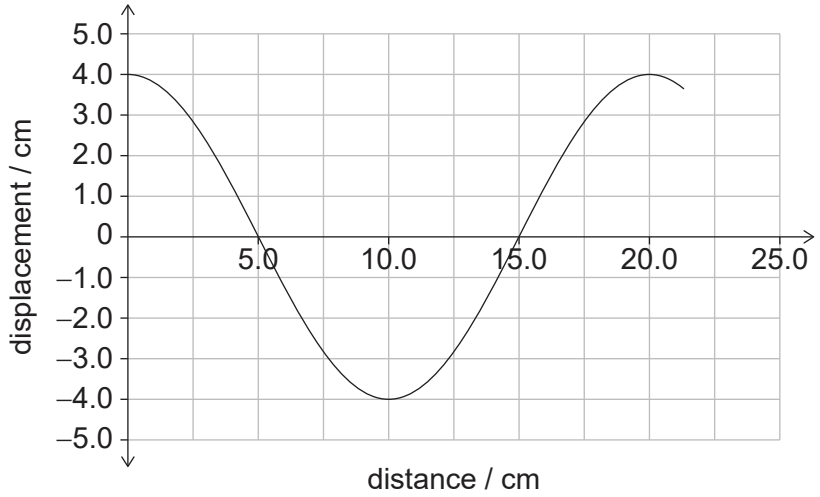
A. $\frac{2\times10^5}{R}$ mol

B. $\frac{200}{R}$ mol

C. $\frac{80}{R}$ mol

D. $\frac{4}{5R}$ mol

13. A wave of period 10 ms travels through a medium. The graph shows the variation of particle displacement with distance for the wave.



What is the average speed of a particle in the medium during one cycle?

A. $4.0\,m\,s^{-1}$

B. $8.0\,m\,s^{-1}$

C. $16\,m\,s^{-1}$

D. $20\,m\,s^{-1}$

14. A light source of power P is observed from a distance d. The power of the source is then halved.

At what distance from the source will the intensity be the same as before?

A. $\frac{d}{\sqrt{2}}$

B. $\frac{d}{2}$

C. $\frac{d}{4}$

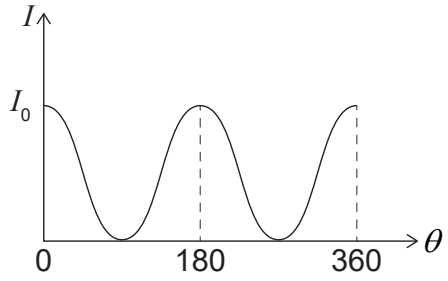
D. $\frac{d}{8}$

15. An interference pattern with minima of zero intensity is observed between light waves. What must be true about the frequency and amplitude of the light waves?

	frequency	amplitude
A.	different	different
B.	different	same
C.	same	same
D.	same	different

16. A beam of unpolarized light of intensity I_0 is incident on a polarizing filter. The polarizing filter is rotated through an angle θ. What is the variation in the intensity I of the beam with angle θ after passing through the polarizing filter?

A.



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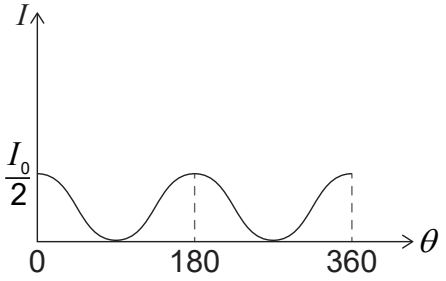

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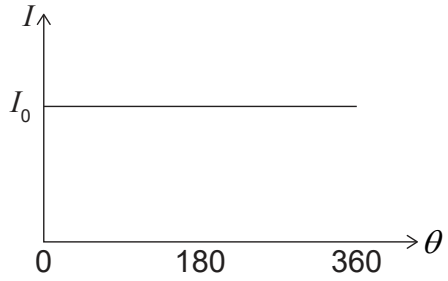
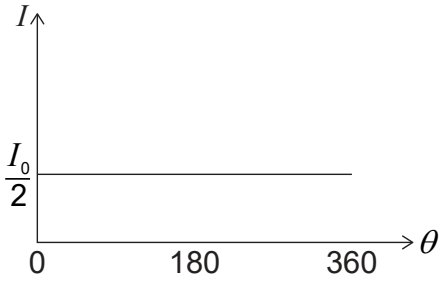
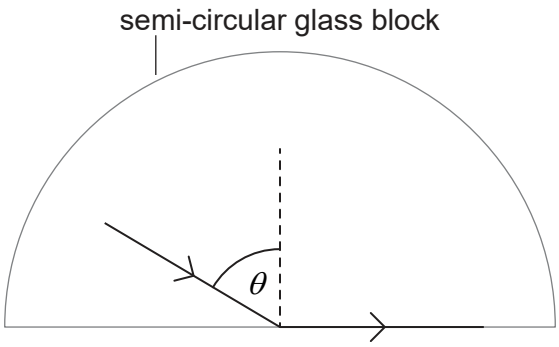


D.



17. A ray of light is incident on the flat side of a semi-circular glass block placed in paraffin. The ray is totally internally reflected inside the glass block as shown.



The refractive index of glass is n_1 and the refractive index of paraffin is n_2.

What is correct?

A. $\sin\theta = \frac{n_1}{n_2}$

B. $\sin\theta = \frac{n_2}{n_1}$

C. $\sin\theta = \frac{1}{n_1}$

D. $\sin\theta = \frac{1}{n_2}$

18. A standing wave is formed on a rope. The distance between the first and fifth antinode on the standing wave is 60 cm. What is the wavelength of the wave?

A. 12 cm

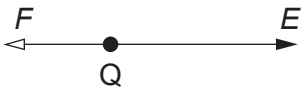
B. 15 cm

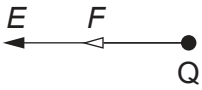
C. 24 cm

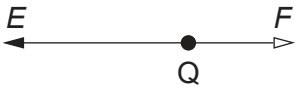
D. 30 cm

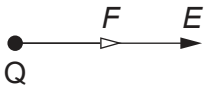
19. P and Q are two opposite point charges. The force *F* acting on P due to Q and the electric field strength *E* at P are shown.

Which diagram shows the force on Q due to P and the electric field strength at Q?

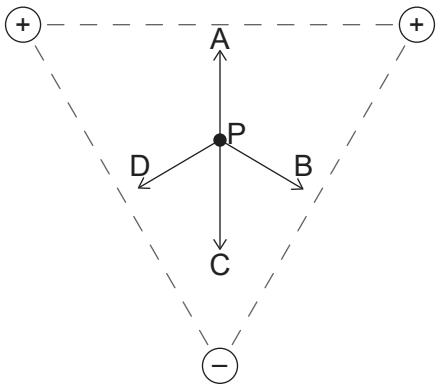
A. 

B. 

C. 

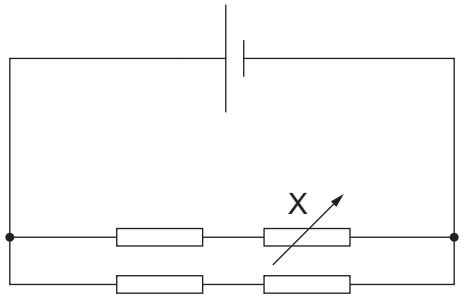
D. 

20. Three point charges of equal magnitude are placed at the vertices of an equilateral triangle. The signs of the charges are shown. Point P is equidistant from the vertices of the triangle. What is the direction of the resultant electric field at P?



21. Three identical resistors each of resistance R are connected with a variable resistor X as shown. X is initially set to R. The current in the cell is 0.60A.

The cell has negligible internal resistance.



X is now set to zero. What is the current in the cell?

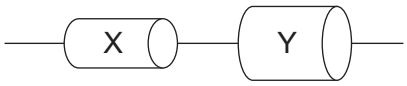
A. 0.45A

B. 0.60A

C. 0.90A

D. 1.80A

22. Two cylinders, X and Y, made from the same material, are connected in series.



The cross-sectional area of Y is twice that of X. The drift speed of the electrons in X is v_X and in Y it is v_Y.

What is the ratio $\frac{v_X}{v_Y}$?

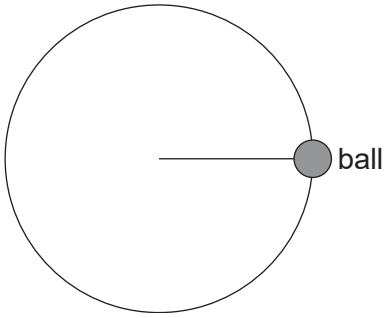
A. 4

B. 2

C. 1

D. $\frac{1}{2}$

23. A ball of mass 0.3 kg is attached to a light, inextensible string. It is rotated in a vertical circle. The length of the string is 0.6 m and the speed of rotation of the ball is $4\,m\,s^{-1}$.



What is the tension when the string is horizontal?

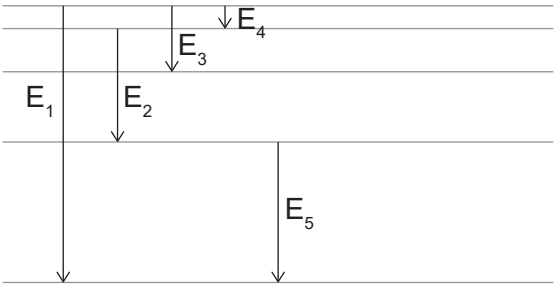
A. 5 N

B. 8 N

C. 11 N

D. 13 N

24. Some transitions between the energy states of a particular atom are shown.



Energy transition E_3 gives rise to a photon of green light. Which transition will give rise to a photon of longer wavelength?

A. E_1

B. E_2

C. E_4

D. E_5

25. Three statements about radioactive decay are:

I. The rate of decay is exponential.

II. It is unaffected by temperature and pressure.

III. The decay of individual nuclei cannot be predicted.

Which statements are correct?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

26. The background count in a laboratory is 20 counts per second. The initial observed count rate of a pure sample of nitrogen-13 in this laboratory is 180 counts per second. The half-life of nitrogen-13 is 10 minutes. What is the expected count rate of the sample after 30 minutes?

A. 20 counts per second

B. 23 counts per second

C. 40 counts per second

D. 60 counts per second

27. $^{238}_{92}U$ undergoes an alpha decay, followed by a beta-minus decay. What is the number of protons and neutrons in the resulting nuclide?

	Number of protons	Number of neutrons
A.	89	234
B.	91	144
C.	91	143
D.	89	145

28. Wind of speed *v* flows through a wind generator. The wind speed drops to $\frac{v}{3}$ after passing through the blades. What is the maximum possible efficiency of the generator?

A. $\frac{1}{27}$

B. $\frac{8}{27}$

C. $\frac{19}{27}$

D. $\frac{26}{27}$

29. Three mechanisms that affect the composition of the atmosphere of the Earth are:

I. Loss of forests that would otherwise store carbon dioxide – CO_2

II. Release of methane – CH_4 by the digestive system of grazing animals

III. Increase of nitrous oxide – N_2O due to extensive use of fertilizer

Which of these statements describe a process that contributes to global warming?

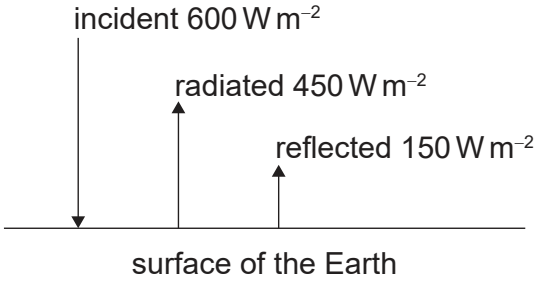
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

30. The diagram shows, for a region on the Earth's surface, the incident, radiated and reflected intensities of the solar radiation.



What is the albedo of the region?

A. $\frac{1}{4}$

B. $\frac{1}{3}$

C. $\frac{3}{4}$

D. 1

References: