Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1

Thursday 28 April 2022 (morning)

1 hour

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 **[40 marks]**.

2222 – 6507

23 pages

1. The intensity of a wave can be defined as the energy per unit area per unit time. What is the unit of intensity expressed in fundamental SI units?

A. $\mathrm{kg\,m^{-2}\,s^{-1}}$

B. $\mathrm{kg\,m^{2}\,s^{-3}}$

C. $\mathrm{kg\,s^{-2}}$

D. $\mathrm{kg\,s^{-3}}$

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. The uncertainty in reading a laboratory thermometer is 0.5 °C. The temperature of a liquid falls from 20 °C to 10 °C as measured by the thermometer. What is the percentage uncertainty in the change in temperature?

A. 2.5 %

B. 5 %

C. 7.5 %

D. 10 %

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

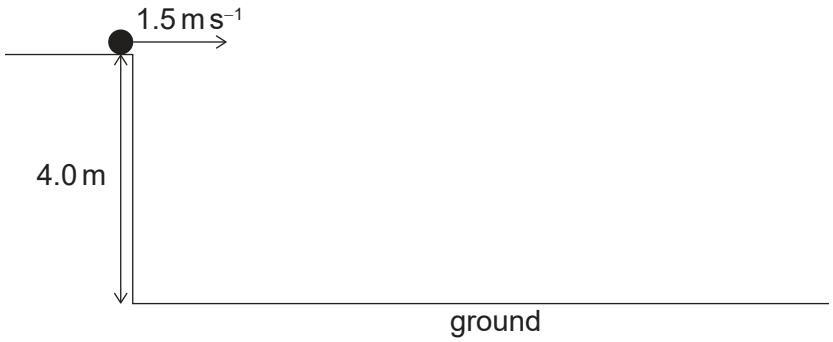
B. $\frac{v}{\sqrt{2}}$

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

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

5. A stone is kicked horizontally at a speed of $1.5\,m\,s^{-1}$ 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?



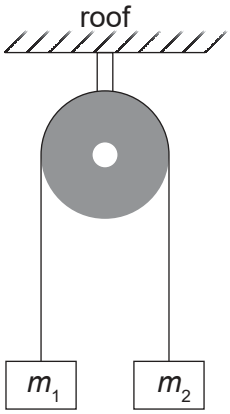
A. 7.0 m

B. 5.0 m

C. 4.0 m

D. 3.0 m

6. 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

7. A book is at rest on a table. One of the forces acting on the book is its weight.

What is the other force that completes the force pair according to Newton's third law of motion?

A. The pull of the book on Earth

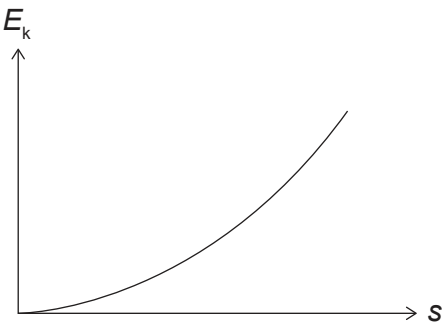
B. The pull of Earth on the book

C. The push of the table on the book

D. The push of the book on the table

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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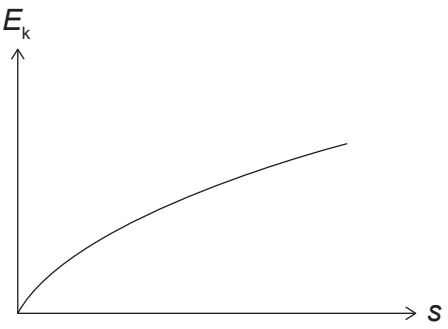
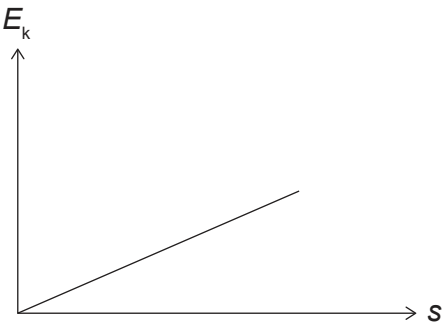


C.

D.



9. Two bodies each of equal mass travelling in opposite directions collide head-on.

What is a possible outcome of the collision?

A. 

B. 

C. 

D. 

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?

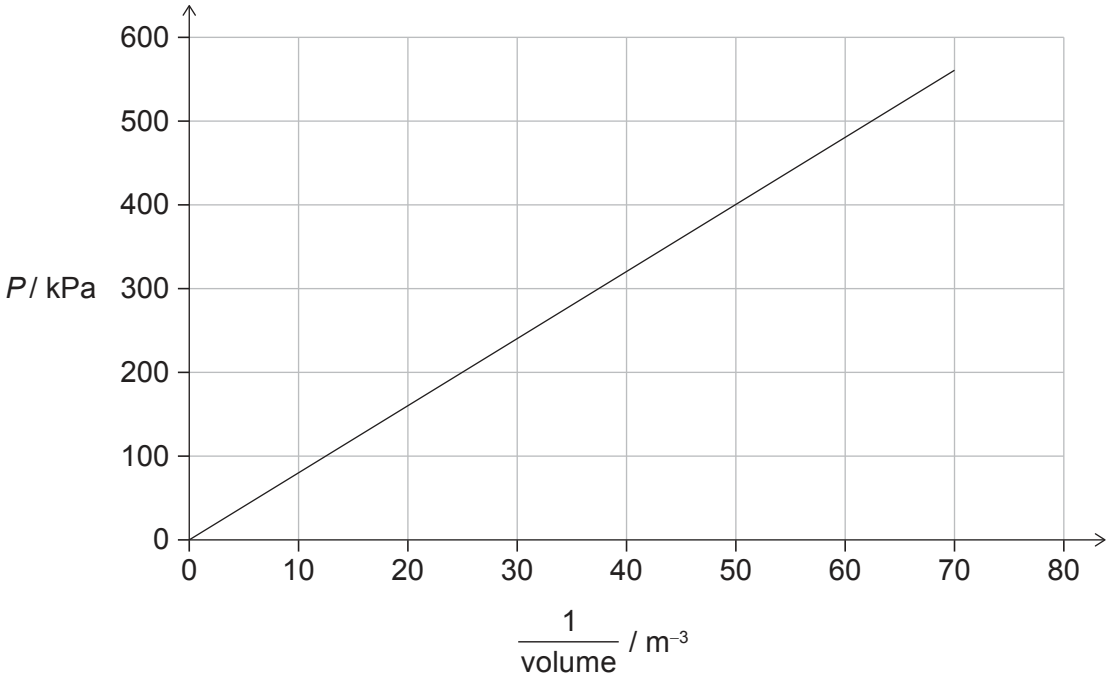
A. $\frac{m}{4}$

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?

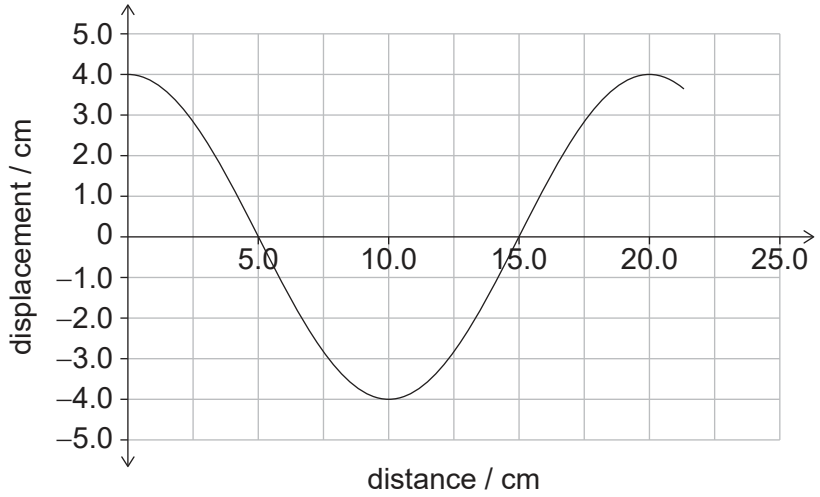
A. $\frac{2\times10^5}{R}$ mol

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

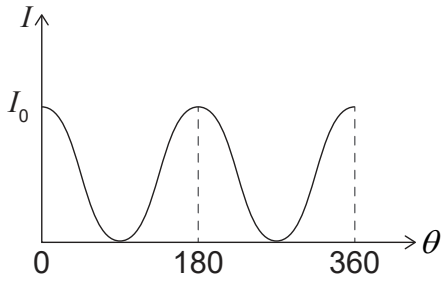
D. $20\,m\,s^{-1}$

14. 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

15. 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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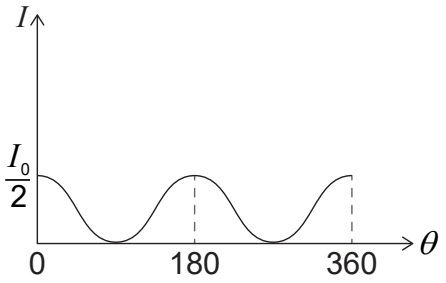

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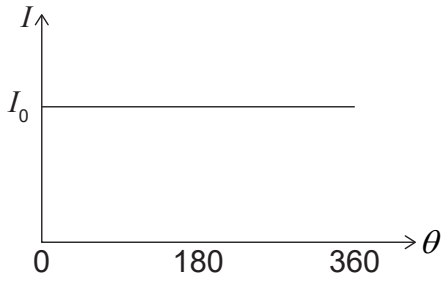
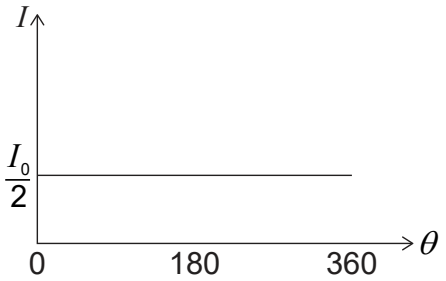
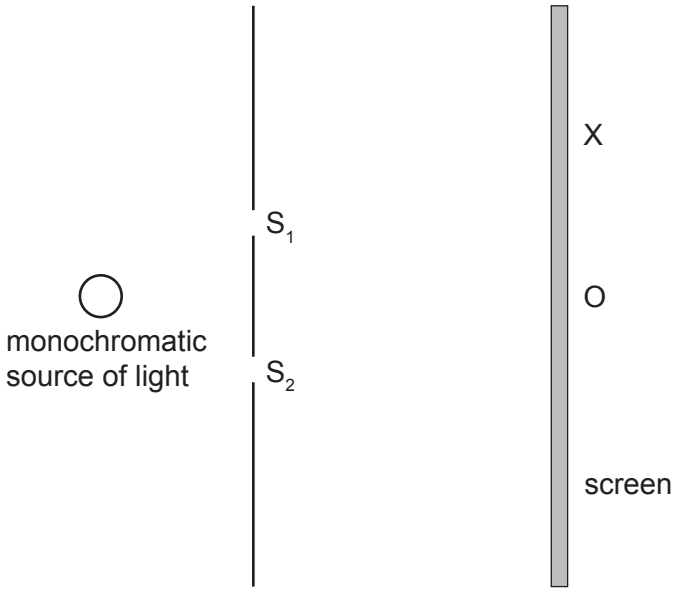


D.



16. Monochromatic light of wavelength λ is incident on two slits S_1 and S_2. An interference pattern is observed on the screen.



O is equidistant from S_1 and S_2. A bright fringe is observed at O and a dark fringe at X.

There are two dark fringes between O and X. What is the path difference between the light arriving at X from the two slits?

A. $\frac{\lambda}{2}$

B. $\frac{3\lambda}{2}$

C. $\frac{5\lambda}{2}$

D. $\frac{7\lambda}{2}$

17. A standing wave is formed on a string. P and Q are adjacent antinodes on the wave. Three statements are made by a student:

I. The distance between P and Q is half a wavelength.

II. P and Q have a phase difference of π rad.

III. Energy is transferred between P and Q.

Which statements are correct?

A. I and II only

B. I and III only

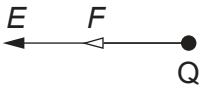
C. II and III only

D. I, II and III

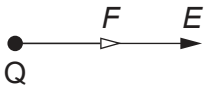
18. P and Q are two opposite point charges. The force *F* acting on P due to Q and the electric field strength *E* at P are shown.

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

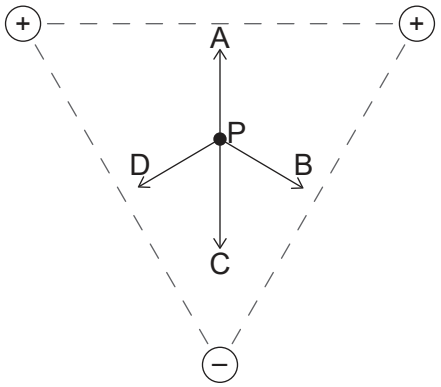
A.


B.


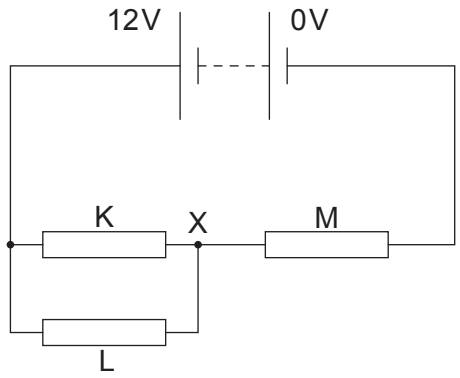
C.


D.


19. 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?



20. In the circuit shown, the battery has an emf of 12 V and negligible internal resistance. Three identical resistors are connected as shown. The resistors each have a resistance of 10 Ω.



The resistor L is removed. What is the change in potential at X?

A. Increases by 2 V

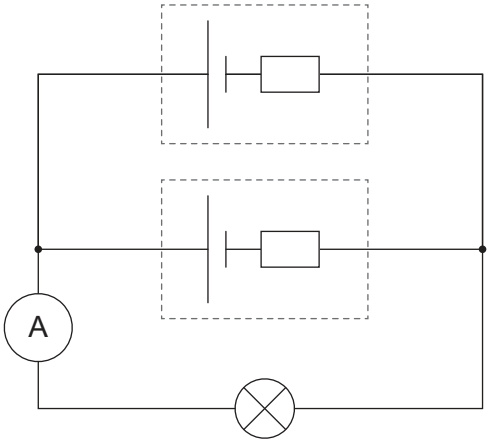
B. Decreases by 2 V

C. Increases by 4 V

D. Decreases by 4 V

21. Two cells are connected in parallel as shown below. Each cell has an emf of 5.0 V and an internal resistance of 2.0 Ω. The lamp has a resistance of 4.0 Ω. The ammeter is ideal.

What is the reading on the ammeter?



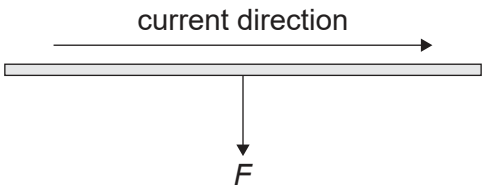
A. 1.0A

B. 1.3A

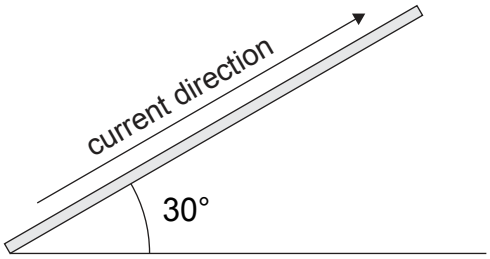
C. 2.0A

D. 2.5A

22. A conductor is placed in a uniform magnetic field perpendicular to the plane of the paper. A force *F* acts on the conductor when there is a current in the conductor as shown.



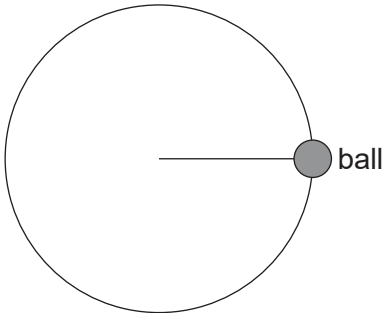
The conductor is rotated 30° about the axis of the magnetic field.



What is the direction of the magnetic field and what is the magnitude of the force on the conductor after the rotation?

	Direction of magnetic field	Magnitude of force
A.	into the plane of the paper	F
B.	into the plane of the paper	$\frac{F}{2}$
C.	out of the plane of the paper	F
D.	out of the plane of the paper	$\frac{F}{2}$

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. P and Q are two moons of equal densities orbiting a planet. The orbital radius of P is twice the orbital radius of Q. The volume of P is half that of Q. The force exerted by the planet on P is *F*. What is the force exerted by the planet on Q?

A. *F*

B. 2*F*

C. 4*F*

D. 8*F*

25. A pure sample of iodine-131 decays into xenon with a half-life of 8 days.

What is $\frac{\text{number of iodine atoms remaining}}{\text{number of xenon atoms formed}}$ after 24 days?

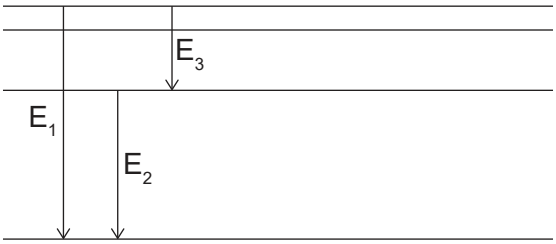
A. $\frac{1}{8}$

B. $\frac{1}{7}$

C. $\frac{7}{8}$

D. $\frac{8}{7}$

26. The diagram shows atomic transitions E_1, E_2 and E_3 when a particular atom changes its energy state. The wavelengths of the photons that correspond to these transitions are λ_1, λ_2 and λ_3.



What is correct for these wavelengths?

A. $\lambda_1 > \lambda_2 > \lambda_3$

B. $\lambda_1 = \lambda_2 + \lambda_3$

C. $\frac{1}{\lambda_1} = \frac{1}{\lambda_2 + \lambda_3}$

D. $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$

27. Carbon (C-12) and hydrogen (H-1) undergo nuclear fusion to form nitrogen.

$$^{12}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H} \rightarrow \mathrm{N} + \text{ photon}$$

What is the number of neutrons and number of nucleons in the nitrogen nuclide?

	Number of neutrons	Number of nucleons
A.	7	13
B.	6	13
C.	6	7
D.	7	6

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?

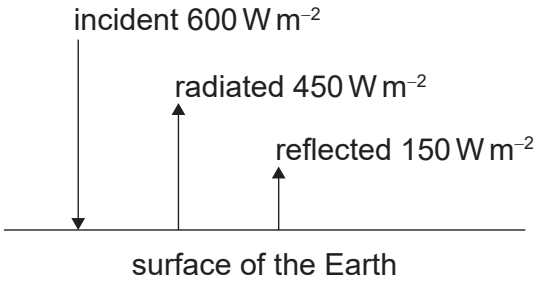
A. $\frac{1}{27}$

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

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

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

29. 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

30. Light of wavelength λ is diffracted after passing through a very narrow single slit of width x. The intensity of the central maximum of the diffracted light is I_0. The slit width is doubled.

What is the intensity of central maximum and the angular position of the first minimum?

	Intensity	Angular position of first minimum
A.	$2I_0$	$\frac{\lambda}{x}$
B.	$2I_0$	$\frac{\lambda}{2x}$
C.	$4I_0$	$\frac{\lambda}{x}$
D.	$4I_0$	$\frac{\lambda}{2x}$

31. An observer with an eye of pupil diameter *d* views the headlights of a car that emit light of wavelength λ. The distance between the headlights is *L*.

What is the greatest distance between the observer and the car at which the images of the headlights will be resolved by the observer's eye?

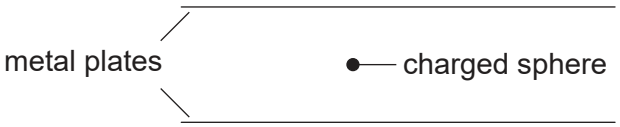
A. $\frac{1.22\lambda}{Ld}$

B. $\frac{1.22\lambda L}{d}$

C. $\frac{Ld}{1.22\lambda}$

D. $\frac{d}{1.22\lambda L}$

32. A charged sphere in a gravitational field is initially stationary between two parallel metal plates. There is a potential difference V between the plates.



Three changes can be made:

I. Increase the separation of the metal plates

II. Increase V

III. Apply a magnetic field into the plane of the paper

What changes made separately will cause the charged sphere to accelerate?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

33. An object of mass m is launched from the surface of the Earth. The Earth has a mass M and radius r. The acceleration due to gravity at the surface of the Earth is g. What is the escape speed of the object from the surface of the Earth?

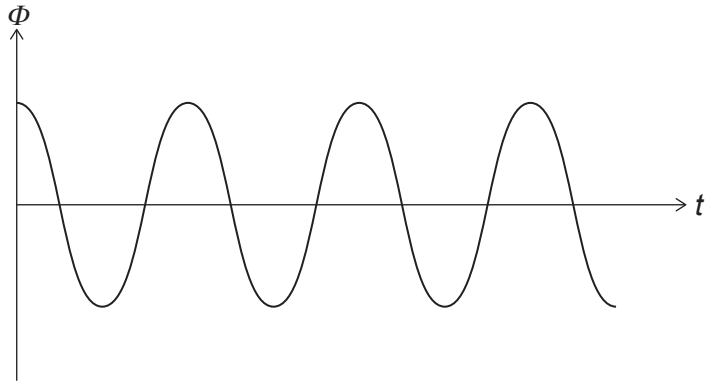
A. $\sqrt{gr}$

B. $\sqrt{2gr}$

C. $\sqrt{2Mgr}$

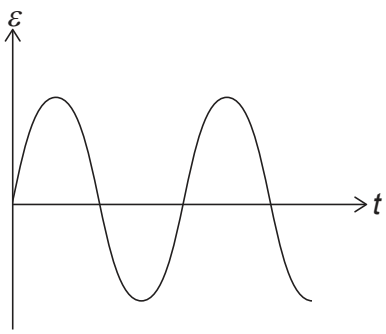
D. $\sqrt{2mgr}$

34. The graph shows the variation of magnetic flux Φ in a coil with time t.

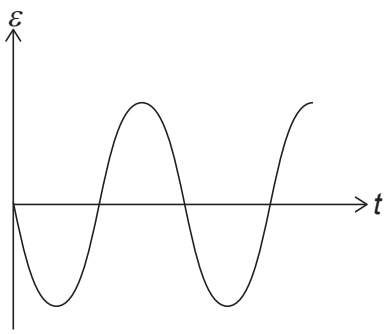


What represents the variation with time of the induced emf ε across the coil?

A.



B.



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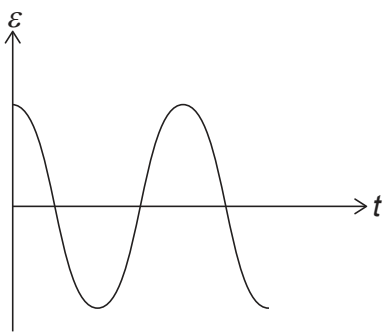

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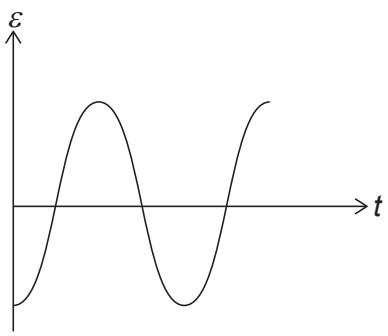


35. A direct current I in a lamp dissipates power *P*. What root mean square (rms) value of an alternating current dissipates average power *P* through the same lamp?

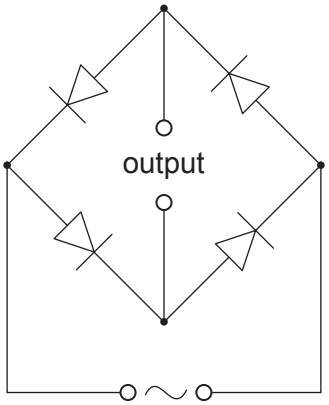
A. $\frac{I}{2}$

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

C. I

D. $I\sqrt{2}$

36. The arrangement shows four diodes connected to an alternating current (ac) supply. The output is connected to an external circuit.



What is the output to the external circuit?

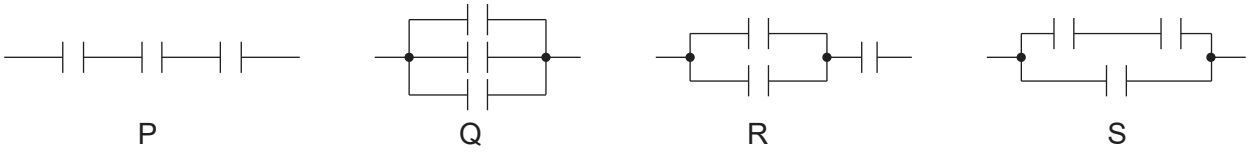
A. Full-wave rectified current

B. Half-wave rectified current

C. Constant non-zero current

D. Zero current

37. Three identical capacitors are connected together as shown.



What is the order of increasing total capacitance for these arrangements?

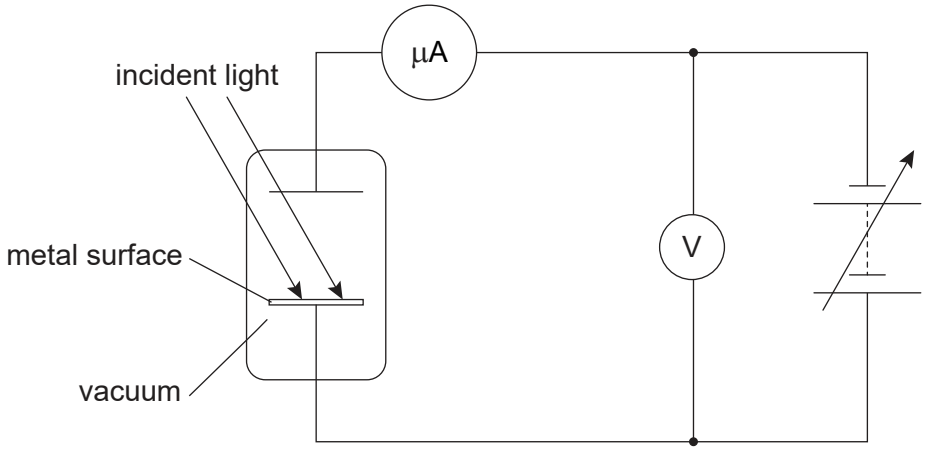
A. P, S, R, Q

B. Q, R, S, P

C. P, R, S, Q

D. Q, S, R, P

38. Light with photons of energy 8.0×10^{-20} J are incident on a metal surface in a photoelectric experiment.



The work function of the metal surface is 4.8×10^{-20} J. What minimum voltage is required for the ammeter reading to fall to zero?

A. 0.2 V

B. 0.3 V

C. 0.5 V

D. 0.8 V

39. What is evidence for wave–particle duality?

A. Line spectra of elements

B. Electron-diffraction experiments

C. Rutherford alpha-scattering experiments

D. Gamma-ray spectra

40. The decay constant, λ, of a radioactive sample can be defined as

A. the number of disintegrations in the radioactive sample.

B. the number of disintegrations per unit time in the radioactive sample.

C. the probability that a nucleus decays in the radioactive sample.

D. the probability that a nucleus decays per unit time in the radioactive sample.

References: