Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1A

29 April 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for paper 1A is **[40 marks]**.
- The maximum mark for paper 1A and paper 1B is **[60 marks]**.

21 pages

2225 – 6713
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1. A ball is initially 50 m above the ground. The ball is thrown vertically upwards and takes 5.0 s to reach the ground. Air resistance is negligible.

What is the initial speed of the ball?

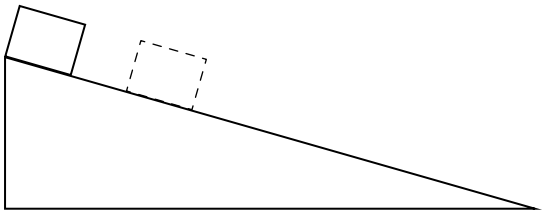
A. $10\,m\,s^{-1}$

B. $15\,m\,s^{-1}$

C. $25\,m\,s^{-1}$

D. $35\,m\,s^{-1}$

2. An object is sliding from rest down a frictionless inclined plane. The vertical displacement of the object is 1.5 m during the first second.



What is the vertical displacement during the next second?

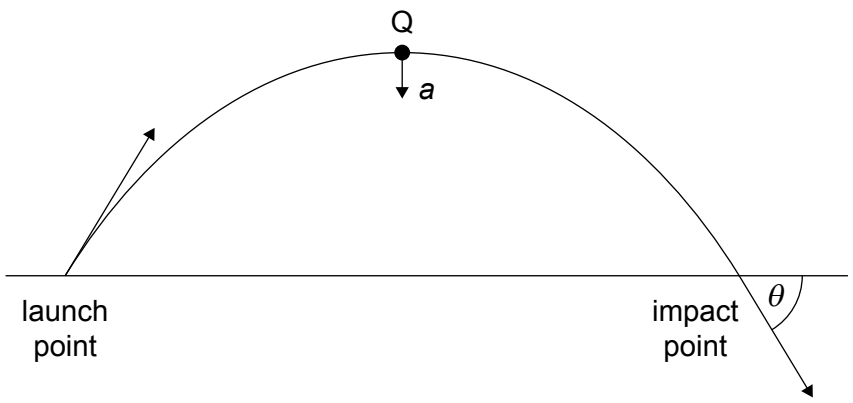
A. 1.5 m

B. 3.0 m

C. 4.5 m

D. 5.0 m

3. The diagram shows the path of a ball in the absence of air resistance. Q is the highest point of the ball's trajectory and *a* is the vertical acceleration at Q. At impact the velocity makes an angle θ to the horizontal.



Three statements about the actual motion of the ball when there is air resistance are:

I. Q is lower.

II. *a* remains the same.

III. θ increases.

Which statements are correct?

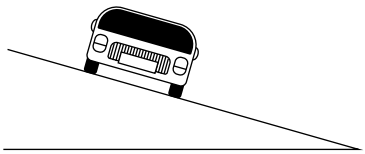
A. I and II only

B. I and III only

C. II and III only

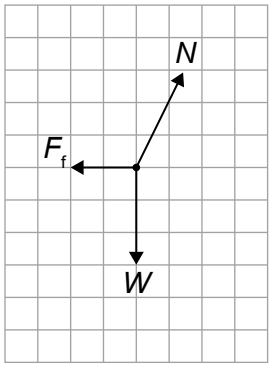
D. I, II and III

4. A car of weight W is travelling at maximum speed in a circular path along a horizontal banked road. The surface exerts a normal force N and a friction force F_f.



What is the correct free-body diagram for the car?

A.



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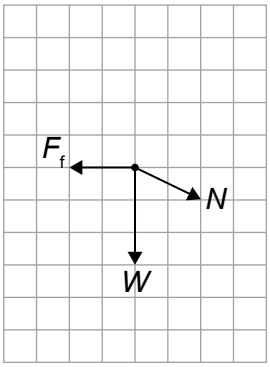

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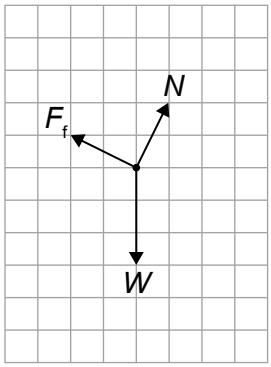

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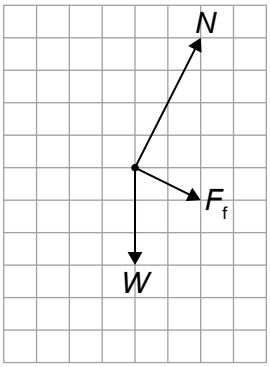


5. Sphere X falls through a fluid with terminal velocity v. Sphere Y is made of the same material and falls through the same fluid. The radius of sphere Y is double that of sphere X.

What is the terminal velocity of sphere Y?

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

B. v

C. $2v$

D. $4v$

6. A wheel, initially at rest, rolls without slipping down an incline for 4.0 s. The final angular velocity of the wheel is 5π rad s^{-1}.

How many revolutions did the wheel complete?

A. 5

B. 10

C. 15

D. 30

7. What is the unit of angular impulse?

A. N s

B. N m

C. N m s^{-1}

D. N m s

8. A car of total mass M is travelling with a constant speed v. Each of the four wheels of the car has a mass m and a radius R and rolls without slipping.

The moment of inertia of each wheel is $I = \frac{1}{2}mR^2$.

What is $\frac{\text{sum of the rotational kinetic energy of all four wheels}}{\text{translational kinetic energy of the car}}$?

A. $\frac{m}{2M}$

B. $\frac{m}{M}$

C. $\frac{2m}{M}$

D. $\frac{4m}{M}$

9. X and Y are two spherical black-body radiators. X has a radius R and emits half the total power of Y. The absolute temperature of X is double that of Y.

What is the radius of Y?

A. $2\sqrt{2}R$

B. $4R$

C. $4\sqrt{2}R$

D. $16R$

10. The albedo of the atmosphere above a small region on the Earth's surface is 0.25. The solar constant is S.

What is the incoming intensity of solar radiation incident on this region when the Sun is directly overhead?

A. $\frac{3S}{16}$

B. $\frac{S}{4}$

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

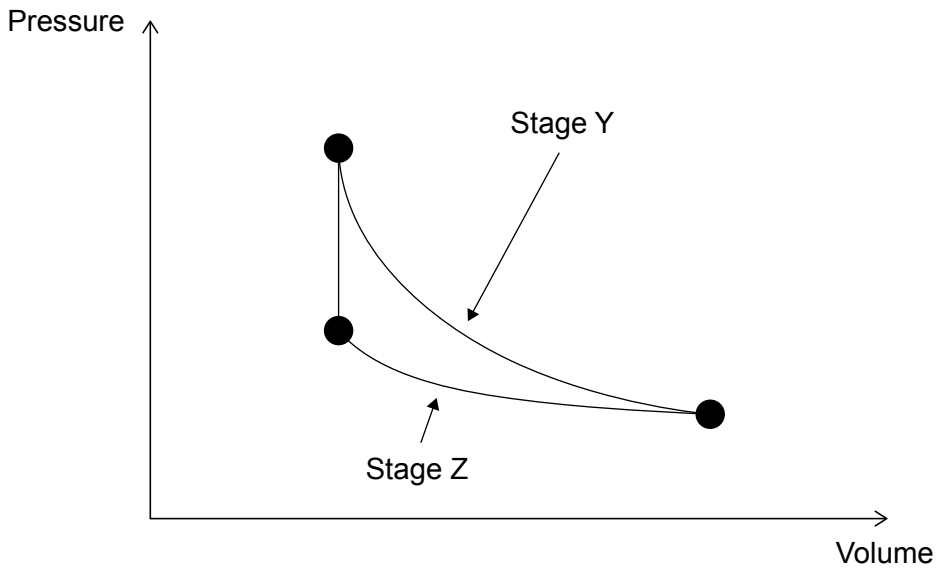
D. S

11. A gas is held in a container. An identical container holds the same number of more massive molecules of another gas at the same temperature.

What is true about the density and pressure in both containers?

	Density in both containers	**Pressure in both containers**
A.	same	same
B.	same	different
C.	different	same
D.	different	different

12. A cyclic process for an ideal gas is shown. The cycle has three stages: isovolumetric, adiabatic, and isothermal. Work is done on the gas during the isothermal stage.



Which stage is isothermal and what is the direction of the cyclic process?

	Stage	**Direction**
A.	Y	Anti-clockwise
B.	Z	Anti-clockwise
C.	Y	Clockwise
D.	Z	Clockwise

13. A wire of length L is used in an electric heater. When the potential difference across the wire is 200 V, the power transferred in the wire is 500 W. A second wire is made from the same metal and has the same cross-sectional area. When a potential difference of 400 V is applied across the second wire, the power transferred is 2000 W.

What is the length of the second wire?

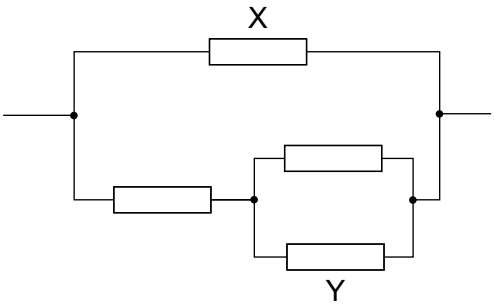
A. $\frac{L}{4}$

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

C. L

D. $2L$

14. Four identical resistors are connected as shown.



What is $\frac{\text{current in X}}{\text{current in Y}}$?

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

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

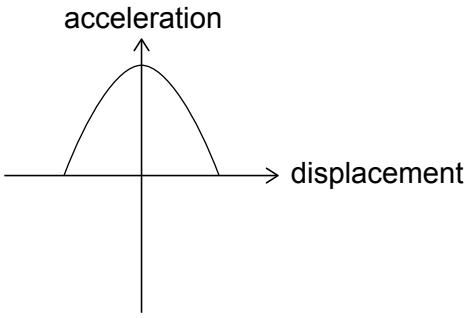
C. $\frac{3}{2}$

D. 3

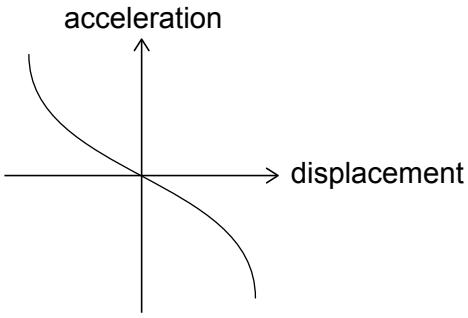
15. A mass–spring system is oscillating with simple harmonic motion.

Which graph represents the variation of acceleration with displacement?

A.



B.



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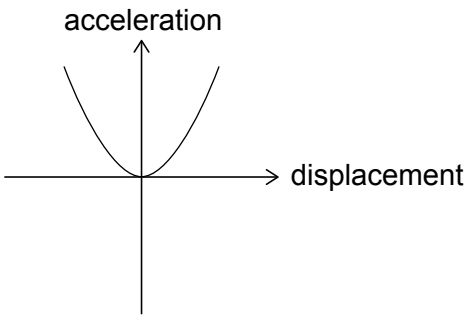
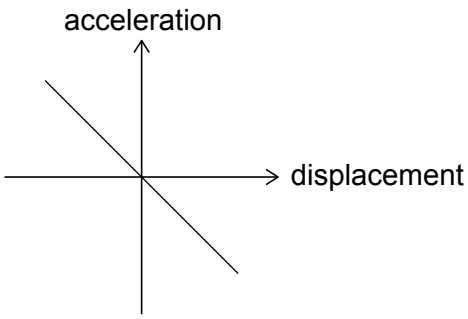


D.



16. A mass–spring system oscillates in simple harmonic motion with maximum elastic potential energy *E*. The mass is tripled and the amplitude is doubled.

What is the new maximum elastic potential energy of the system?

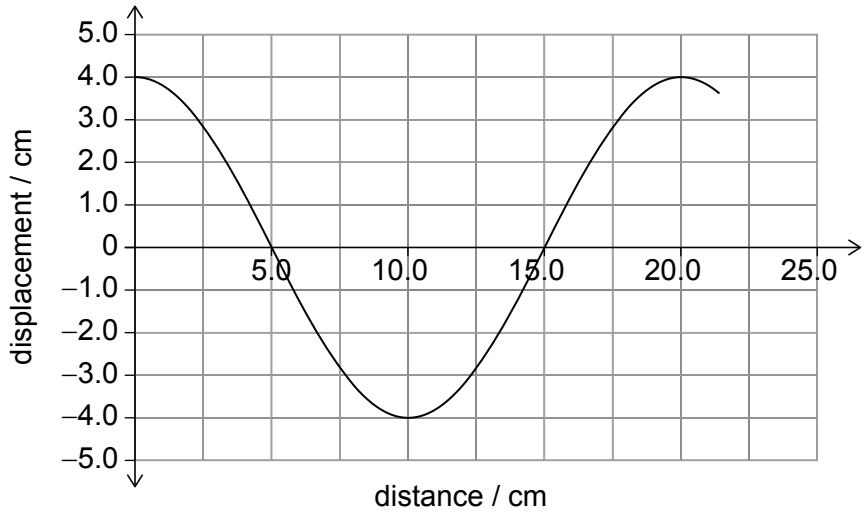
A. $\frac{4}{3}E$

B. $4E$

C. $6E$

D. $12E$

17. A transverse wave of period 20 ms travels through a medium. The graph shows the variation of particle displacement with distance for the wave.



What is the average speed of the particle motion and the direction of particle motion relative to the direction of the wave travel during one cycle?

	Average speed of particle / m s^{-1}	**Direction of particle motion**
A.	8	parallel
B.	8	perpendicular
C.	10	parallel
D.	10	perpendicular

18. An ultraviolet wave is travelling in a vacuum.

What is the frequency and the nature of the wave?

	Wave frequency / Hz	Nature of the wave
A.	10^{15}	transverse
B.	10^{15}	longitudinal
C.	10^{-7}	transverse
D.	10^{-7}	longitudinal

19. A fifth-harmonic standing wave is formed in a pipe of length 25 cm that is closed at both ends.

What two points along the pipe have a phase difference of π ?

A. 2 cm and 7 cm

B. 4 cm and 21 cm

C. 7 cm and 9 cm

D. 11 cm and 14 cm

20. For a lightly damped oscillation…

A. the amplitude goes to zero within one period of oscillation.

B. the oscillation frequency does not change with time.

C. energy is transferred from the oscillation as quickly as possible.

D. the oscillation frequency equals the undamped oscillation frequency.

21. A planet of mass m is in a circular orbit of radius R around a star. The orbital speed of the planet is v. A second planet of mass $2m$ is in a circular orbit of radius $1.5R$ around the same star.

What is the orbital speed of the second planet?

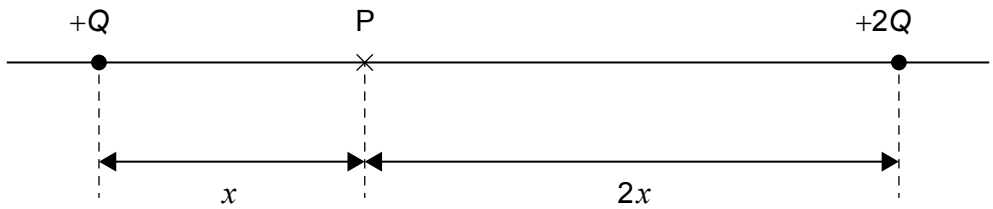
A. $\sqrt{\frac{2}{3}}v$

B. $\sqrt{2}v$

C. $\sqrt{3}v$

D. $2v$

22. A charge $+Q$ and a charge $+2Q$ are a distance $3x$ apart. Point P is on the line joining the charges, at a distance x from one of the charges as shown.



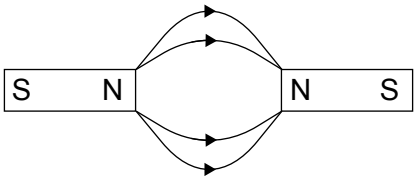
What is the electric field strength E at P?

	Magnitude of E	Direction of E
A.	$\frac{kQ}{2x^2}$	left
B.	$\frac{kQ}{2x^2}$	right
C.	$\frac{kQ}{x^2}$	left
D.	$\frac{kQ}{x^2}$	right

23. Two bar magnets are held in place with the north poles facing each other.

Which diagram shows four correct magnetic field lines?

A.



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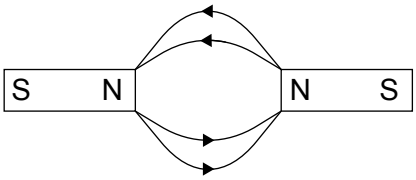
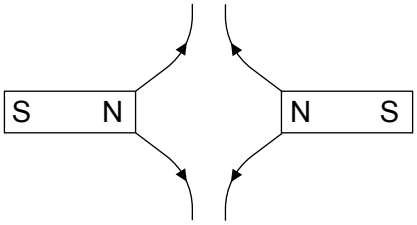
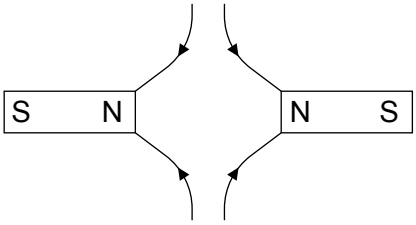


C.



D.

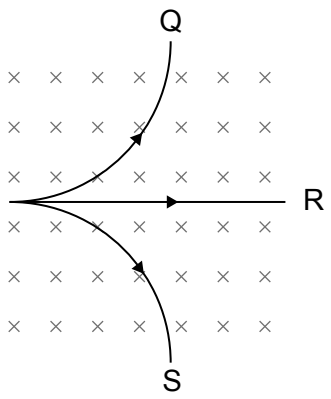


24. A pair of parallel conducting plates are separated by 50 cm. The electric potential of one plate is +200 V and the electric potential of the other plate is +450 V. A proton travels from the +200 V plate to the +450 V plate.

What is the electric field strength between the plates and the change in the kinetic energy of the proton?

	Magnitude / N C^{-1}	**Change in kinetic energy**
A.	500	positive
B.	500	negative
C.	900	positive
D.	900	negative

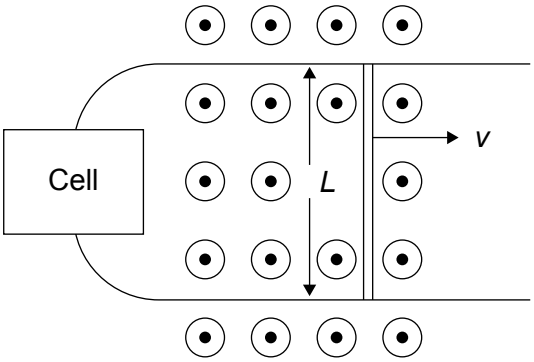
25. The diagram shows possible paths Q, R, and S of particles moving into a region of uniform magnetic field. The field is directed into the plane of the page.



What particles are shown by each path?

	Q	**R**	**S**
A.	proton	neutron	electron
B.	neutron	electron	alpha particle
C.	electron	neutron	alpha particle
D.	proton	electron	neutron

26. A circuit is created with a cell, two parallel conducting wires and a moveable metal rod of length L. When a uniform magnetic field B is directed out of the page through the circuit, the metal rod moves to the right with velocity v. The initial current in the circuit is I.



What is the direction of the current through the circuit and the initial force on the metal rod?

	Direction of I	Initial force on the metal rod
A.	anti-clockwise	$BIL\sin(90°)$
B.	clockwise	$BIL\sin(90°)$
C.	anti-clockwise	$BIL\sin(0°)$
D.	clockwise	$BIL\sin(0°)$

27. Two parallel wires X and Y carry the same current. There is a repulsive force per unit length F on each wire. The direction of the current in each wire is reversed. The current in X is doubled and the current in Y stays the same. The separation of X and Y is also doubled.

What is the magnitude and direction of the force per unit length on each wire?

	Magnitude	Direction
A.	F	repulsive
B.	F	attractive
C.	$\frac{F}{2}$	repulsive
D.	$\frac{F}{2}$	attractive

28. A horizontal conducting ring is perpendicular to a uniform vertical magnetic field. When the ring is rotated through 180° about the horizontal axis, an average emf of 2.0 μV is induced in the ring. The area enclosed by the ring is 4.0 cm^2 and the rotation takes 2.0 s.

What is the magnetic field?

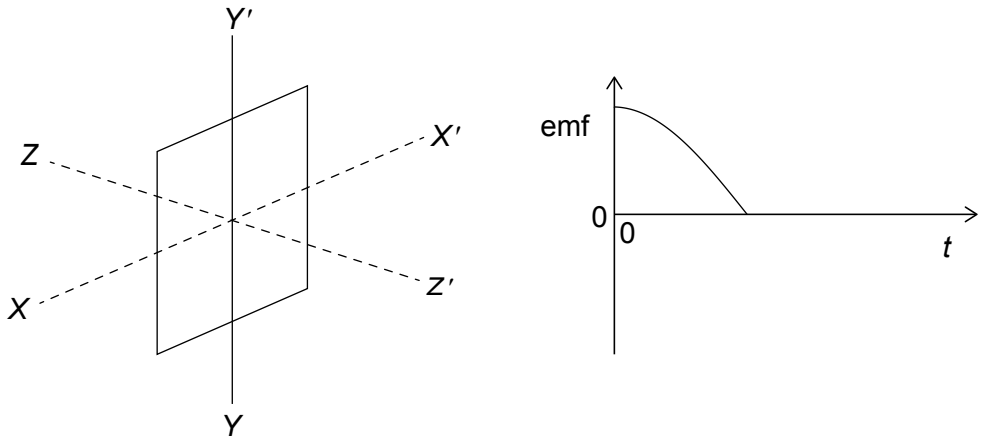
A. 2.5 mT

B. 5.0 mT

C. 10.0 mT

D. 20.0 mT

29. A rectangular coil rotates at a constant angular velocity. At the instant shown, the plane of the coil is at right angles to the line *ZZ′*. A uniform magnetic field acts in the direction *YY′*. The variation of emf with time *t* is shown.



What coil rotation about the axis specified produces this graph?

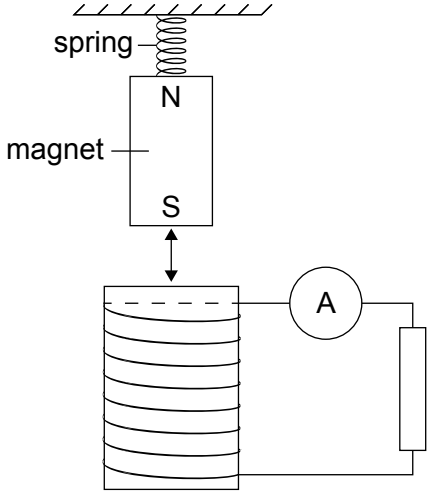
A. Through $\frac{\pi}{2}$ about *XX′*

B. Through π about *XX′*

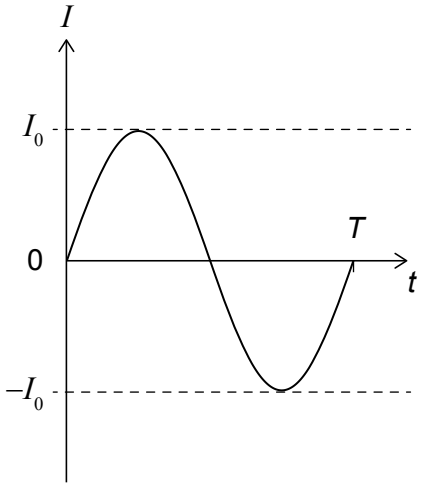
C. Through $\frac{\pi}{2}$ about *YY′*

D. Through π about *YY′*

30. A magnet attached to a spring oscillates above a coil as shown. The period of the oscillation is *T*.



The graph shows the variation with time *t* of the current I in the coil.



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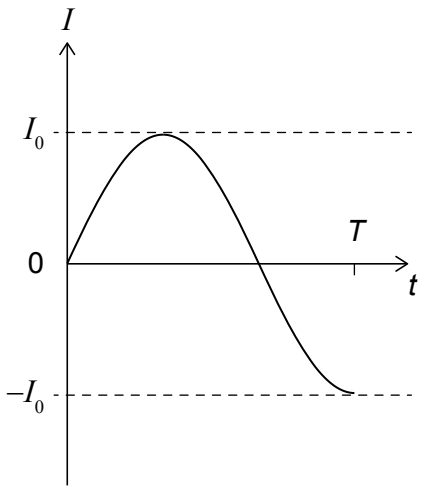
(Question 30 continued)

The amplitude of the magnet's oscillation is now decreased.

What is the new variation of I with t?

A.



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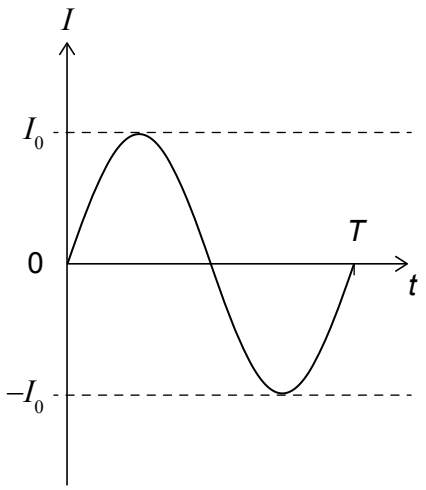

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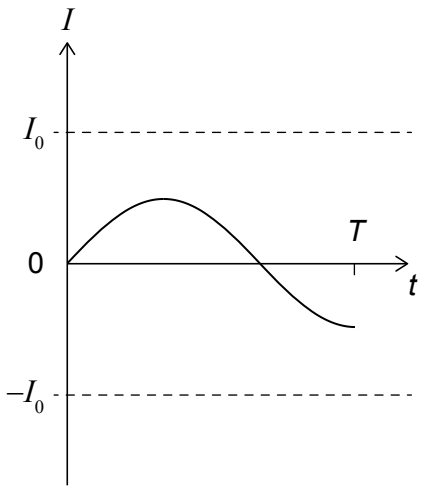

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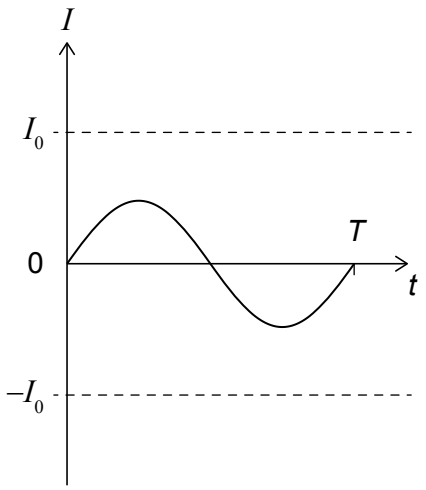


31. Gases in the atmosphere are compounds of ${}^{12}_{6}C$, ${}^{1}_{1}H$, ${}^{16}_{8}O$ and ${}^{14}_{7}N$.

Four of these gases are CO_2, N_2O, CH_4 and H_2O. A pure sample of each gas is produced. Each sample has the same volume, pressure, and temperature.

Which sample has the smallest mass?

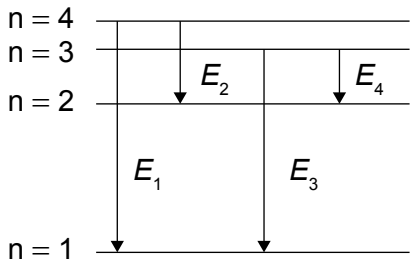
A. CH_4

B. N_2O

C. CO_2

D. H_2O

32. Some transitions between the energy states of an atom are shown.



Which transition will emit a photon with the longest wavelength?

A. E_1

B. E_2

C. E_3

D. E_4

33. In the Geiger–Marsden–Rutherford experiment, alpha particles were accelerated through a potential difference of 7.7 MV and incident on a thin foil of gold. The proton number of gold is 79.

What is the distance of closest approach?

A. $\dfrac{158ke}{7.7 \times 10^6}$

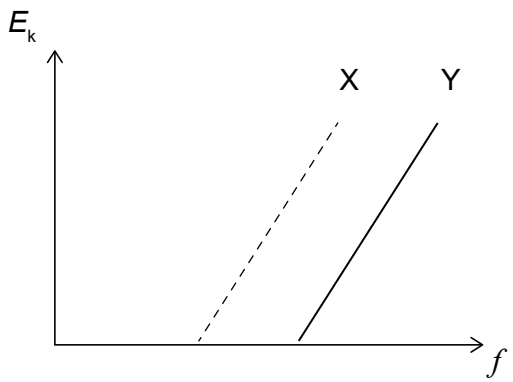
B. $\dfrac{158ke^2}{7.7 \times 10^6}$

C. $\dfrac{79ke}{7.7 \times 10^6}$

D. $\dfrac{79ke^2}{7.7 \times 10^6}$

34. In two experiments X and Y measurements were made of the kinetic energies E_k of photoelectrons emitted when light is incident on two different metal surfaces.

The graph shows the variation of E_k with frequency f of the incident photons for both surfaces.



It can be deduced that in experiment Y…

A. the surface has a smaller work function than the surface in experiment X.

B. the surface has a larger work function than the surface in experiment X.

C. the intensity of the incident light is less than in experiment X.

D. the intensity of the incident light is more than in experiment X.

35. The intensity of electromagnetic radiation incident on a surface is I. The wavelength of the radiation is doubled and the number of photons incident per unit time per unit area is doubled.

What is the new intensity of radiation incident on the surface?

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

B. I

C. $2I$

D. $4I$

36. A fusion reaction of one nucleus of hydrogen-2 and one nucleus of hydrogen-3 converts a mass of 0.024 u into energy. A fission reaction of one nucleus of uranium-235 converts a mass of 0.48 u into energy.

What is $\frac{\text{energy released per unit mass of hydrogen}}{\text{energy released per unit mass of uranium}}$?

A. 0.050

B. 0.426

C. 2.35

D. 20.0

37. Three statements about gamma radiation are:

I. It travels faster than beta radiation in a vacuum.

II. It has a greater penetration ability than beta radiation.

III. It has a greater ionizing ability than beta radiation.

Which statements are correct?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

38. A pure sample of 4.4 g of Radon-222 has an activity of 2.5×10^{16} Bq.

What is the decay constant of Radon-222?

A. $2.1 \times 10^{-10}\,s^{-1}$

B. $8.3 \times 10^{-10}\,s^{-1}$

C. $2.1 \times 10^{-6}\,s^{-1}$

D. $8.3 \times 10^{-6}\,s^{-1}$

39. The moderator in a nuclear power station…

A. increases the proportion of U-235 in the fuel source.

B. transfers internal energy from the reactor to the turbines.

C. allows operators to regulate the rate of power production.

D. decreases the kinetic energy of neutrons in the reactor.

40. Stars X and Y have the same surface temperature. Star X has a radius R and is a distance d from Earth. The distance of star Y from Earth is $\frac{d}{2}$. The apparent brightness of Y is double that of X.

What is the radius of star Y?

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

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

C. R

D. $2R$