



**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Monday 8 November 2010 (afternoon)

1 hour

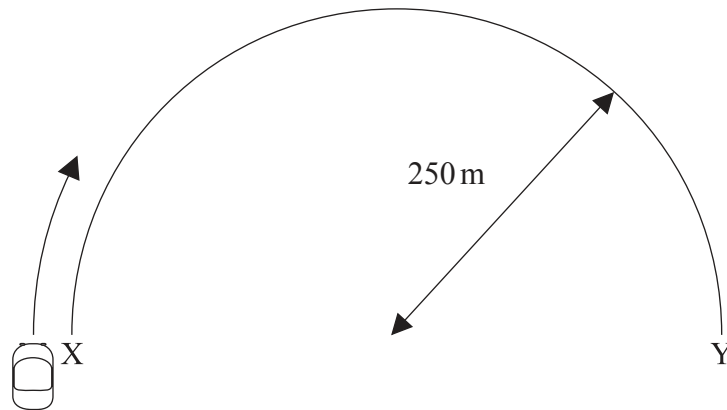
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**INSTRUCTIONS TO CANDIDATES**

- 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.

1. Which of the following is equivalent to the joule?
- A.  $\text{Nm}^2$
  - B.  $\text{Nm}^{-2}$
  - C.  $\text{kgms}^{-2}$
  - D.  $\text{kgm}^2\text{s}^{-2}$
2. Two lengths,  $a$  and  $b$ , are measured to be  $51 \pm 1$  cm and  $49 \pm 1$  cm respectively. In which of the following quantities is the percentage uncertainty the largest?
- A.  $a+b$
  - B.  $a-b$
  - C.  $a \times b$
  - D.  $\frac{a}{b}$
3. A net force of magnitude 4.0 N acts on a body of mass 3.0 kg for 6.0 s. The body is initially at rest. Which of the following is the speed of the body after the 6.0 s interval?
- A.  $0.50 \text{ms}^{-1}$
  - B.  $2.0 \text{ms}^{-1}$
  - C.  $4.5 \text{ms}^{-1}$
  - D.  $8.0 \text{ms}^{-1}$

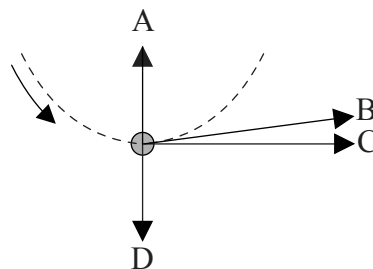
4. A car moves from X to Y along a semicircular path. The radius of the path is 250 m and the time taken to complete the trip is 50 s.



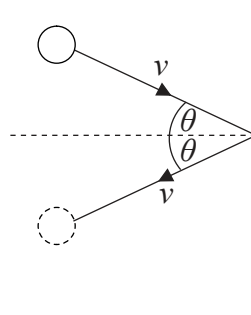
Which of the following correctly shows the magnitude of the average velocity and the magnitude of the average speed?

	Average velocity	Average speed
A.	$10 \text{ ms}^{-1}$	$10 \text{ ms}^{-1}$
B.	$10 \text{ ms}^{-1}$	$16 \text{ ms}^{-1}$
C.	$16 \text{ ms}^{-1}$	$10 \text{ ms}^{-1}$
D.	$16 \text{ ms}^{-1}$	$16 \text{ ms}^{-1}$

5. A ball is tied to a string and rotated at a uniform speed in a vertical plane. The diagram shows the ball at its lowest position. Which arrow shows the direction of the net force acting on the ball?

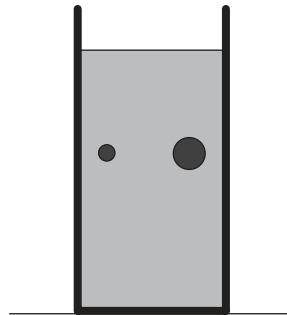


6. A gas atom strikes a wall with speed  $v$  at an angle  $\theta$  to the normal to the wall. The atom rebounds at the same speed  $v$  and angle  $\theta$ .



Which of the following gives the magnitude of the momentum change of the gas atom?

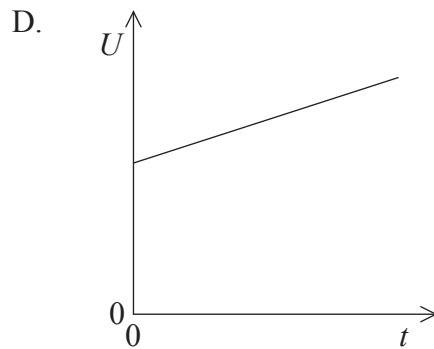
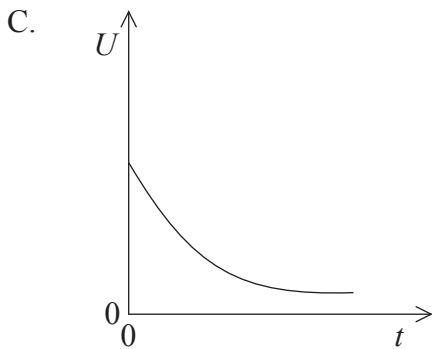
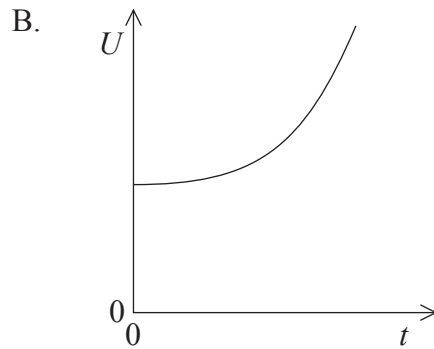
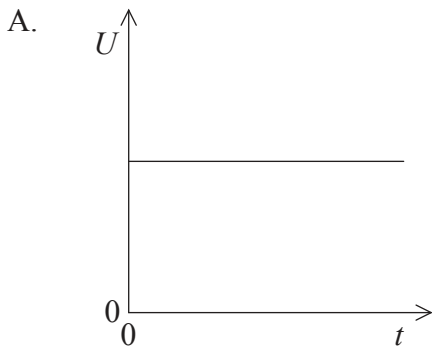
- A. zero
  - B.  $2mv \sin\theta$
  - C.  $2mv$
  - D.  $2mv \cos\theta$
7. Two steel balls, of mass  $M$  and  $2M$ , fall at constant speeds in a tube filled with oil.



Which of the following correctly compares the magnitudes of the net force and of the drag (resistance) force on the two balls?

	Net force	Drag force
A.	same	same
B.	same	different
C.	different	same
D.	different	different

8. A system consists of an ice cube placed in a cup of water. The system is thermally insulated from its surroundings. The water is originally at  $20^{\circ}\text{C}$ . Which graph best shows the variation of total internal energy  $U$  of the system with time  $t$ ?



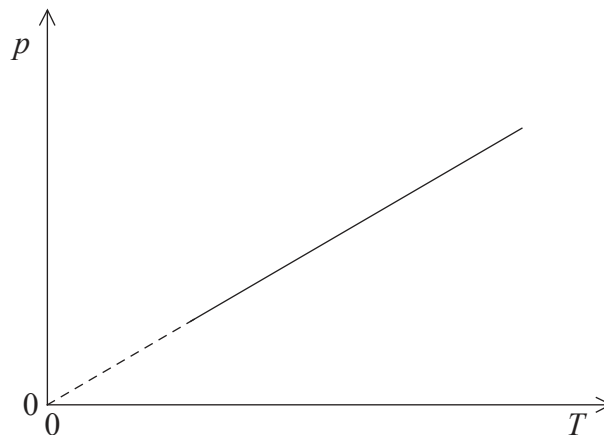
9. An ice cube and an iceberg are both at a temperature of  $0^{\circ}\text{C}$ . Which of the following is a correct comparison of the average random kinetic energy and the total kinetic energy of the molecules of the ice cube and the iceberg?

	Average random kinetic energy	Total kinetic energy
A.	same	same
B.	same	different
C.	different	same
D.	different	different

10. An ideal gas expands isothermally from a state X to a new state of volume  $V$ . The work done by the gas is  $W$ . Which of the following is correct for an adiabatic expansion of the gas from state X to a new state of volume  $V$ ?

	Change in internal energy	Work done
A.	$\Delta U > 0$	greater than $W$
B.	$\Delta U < 0$	greater than $W$
C.	$\Delta U > 0$	less than $W$
D.	$\Delta U < 0$	less than $W$

11. The graph shows the variation with absolute temperature  $T$  of the pressure  $p$  of a fixed mass of an ideal gas.

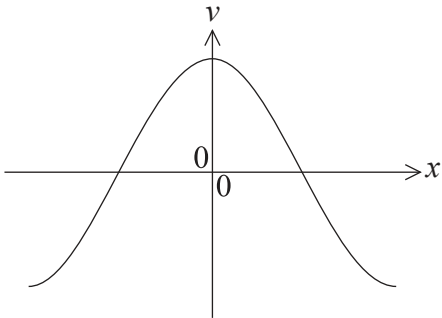


Which of the following is correct concerning the volume and the density of the gas?

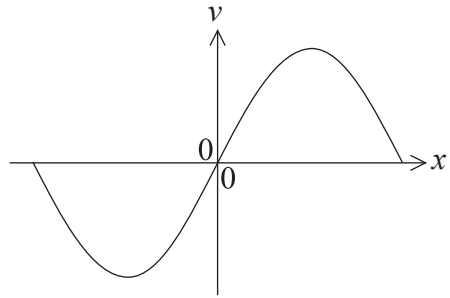
	Volume	Density
A.	constant	constant
B.	constant	increasing
C.	increasing	constant
D.	increasing	increasing

12. Which of the following graphs shows the variation with displacement  $x$  of the speed  $v$  of a particle performing simple harmonic motion.

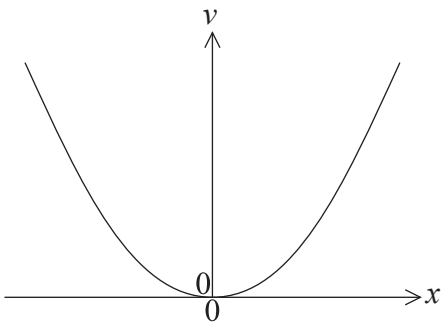
A.



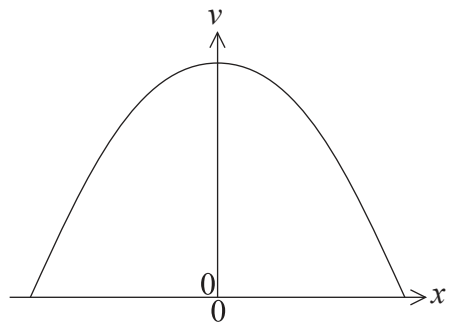
B.



C.



D.



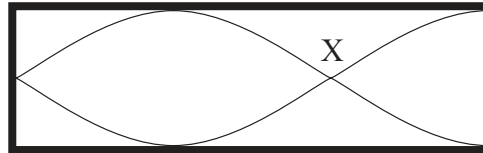
13. A particle performs simple harmonic oscillations. Which of the following quantities will be unaffected by a reduction in the amplitude of oscillations?

- A. The total energy
- B. The maximum speed
- C. The maximum acceleration
- D. The period

14. Monochromatic light travels from air into water. Which of the following describes the changes in wavelength and speed?

	<b>Wavelength</b>	<b>Speed</b>
A.	increases	decreases
B.	increases	increases
C.	decreases	increases
D.	decreases	decreases

15. A standing wave is established in air in a pipe with one closed and one open end.



The air molecules near X are

- A. always at the centre of a compression.
- B. always at the centre of a rarefaction.
- C. sometimes at the centre of a compression and sometimes at the centre of a rarefaction.
- D. never at the centre of a compression or a rarefaction.



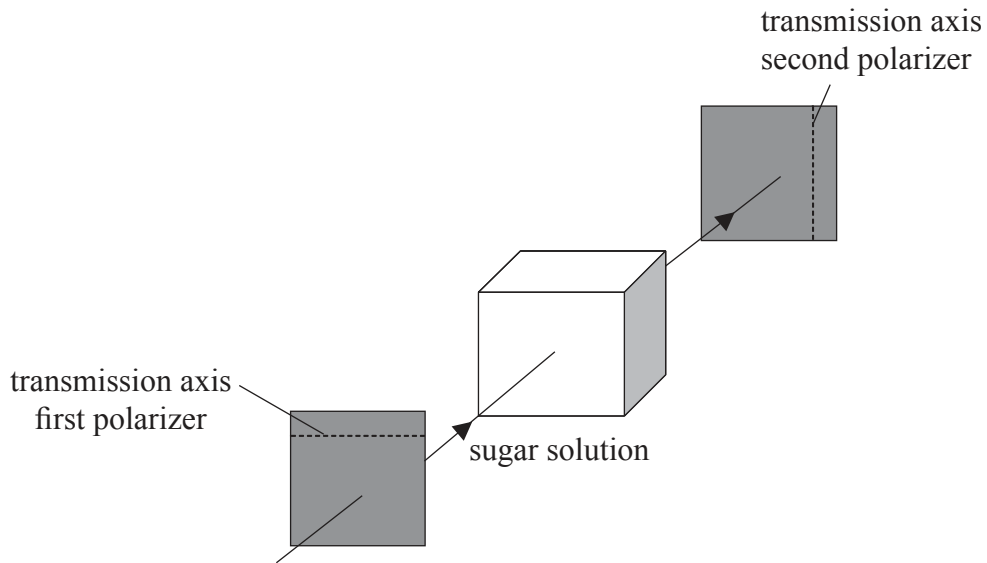
16. In two separate experiments monochromatic light is incident on a single slit. The diagrams show the diffraction patterns obtained on a screen far from the slit. In the top diagram the wavelength of light is  $\lambda_1$  and the slit width is  $b_1$ . In the bottom diagram the wavelength of light is  $\lambda_2$  and the slit width is  $b_2$ .



In each experiment the distance between the slit and the screen is the same. Which of the following may be deduced?

- A.  $\frac{\lambda_1}{b_1} < \frac{\lambda_2}{b_2}$
- B.  $\frac{\lambda_1}{b_1} > \frac{\lambda_2}{b_2}$
- C.  $b_1 < b_2$
- D.  $\lambda_1 > \lambda_2$

17. Horizontally polarized light is transmitted through a polarizer whose transmission axis is horizontal. The light enters a container with a sugar solution and is then incident on a second polarizer whose transmission axis is vertical.

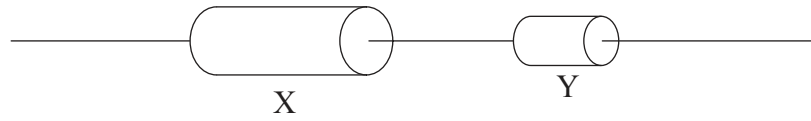


When the second polarizer is rotated by a small angle, no light is transmitted through the second polarizer. The explanation for this observation is that the sugar solution

- A. causes destructive interference.
  - B. rotates the plane of polarization of light.
  - C. can only transmit vertically polarized light.
  - D. refracts light so no light is incident on the second polarizer.
18. A source of sound approaches a stationary observer. The speed of the emitted sound and its wavelength, measured at the source, are  $v$  and  $\lambda$  respectively. Which of the following is the wave speed and the wavelength, as measured by the stationary observer?

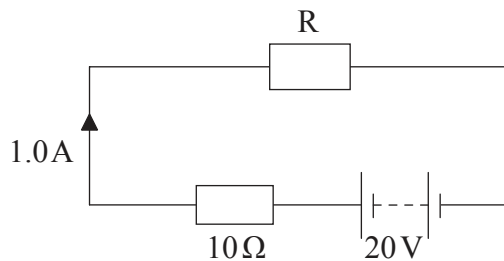
	Wave speed	Wavelength
A.	larger than $v$	larger than $\lambda$
B.	equal to $v$	larger than $\lambda$
C.	equal to $v$	less than $\lambda$
D.	larger than $v$	less than $\lambda$

19. Two resistors, made of the same material, are connected in series to a battery. The length of resistor X is twice that of resistor Y, and X has twice the cross-sectional area of Y.



Which of the following gives  $\frac{\text{resistance of X}}{\text{resistance of Y}}$ ?

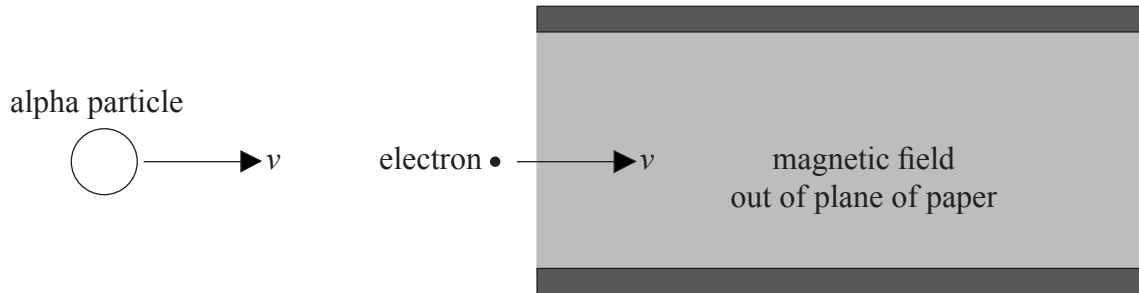
- A.  $\frac{1}{4}$
- B.  $\frac{1}{2}$
- C. 1
- D. 4
20. The circuit shows a resistor R connected in series with a battery and a resistor of resistance  $10\Omega$ . The emf of the battery is  $20\text{V}$  and it has negligible internal resistance. The current in the circuit is  $1.0\text{A}$ .



Which of the following is the resistance of R?

- A.  $1.0\Omega$
- B.  $2.0\Omega$
- C.  $10\Omega$
- D.  $20\Omega$

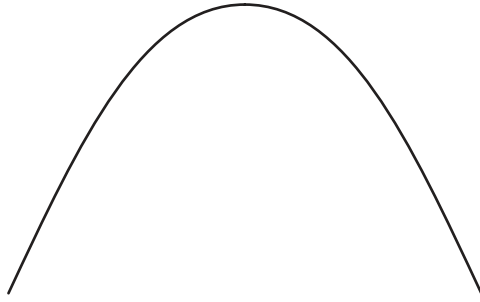
21. An electron enters the vacuum between two oppositely charged plates with velocity  $v$ . The electron is followed by an alpha particle moving with the same initial velocity as the electron. A uniform magnetic field is directed out of the plane of the paper.



The electron's path is undeflected. The path of the alpha particle will be

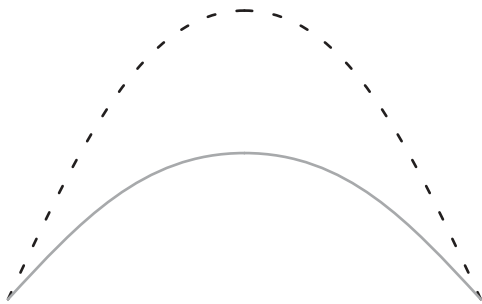
- A. deflected out of the plane of the paper.
  - B. undeflected.
  - C. deflected upward.
  - D. deflected downward.
22. The mass of a planet is twice that of Earth. Its radius is half that of the radius of Earth. The gravitational field strength at the surface of Earth is  $g$ . The gravitational field strength at the surface of the planet is
- A.  $\frac{1}{2}g$ .
  - B.  $g$ .
  - C.  $2g$ .
  - D.  $8g$ .

23. The diagram shows the path of a projectile that is launched with velocity  $v$ . Air resistance is negligible.

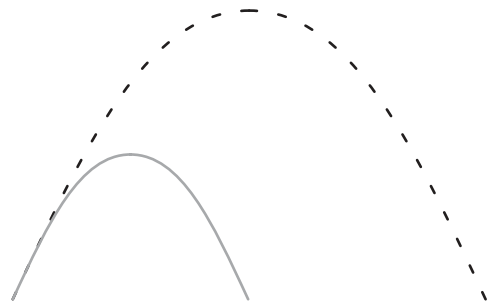


A second projectile has double the mass of the first projectile and is launched with the same velocity. Air resistance is still negligible. Which of the following paths best represents the path of the projectile? (The original path is shown as a dotted line)

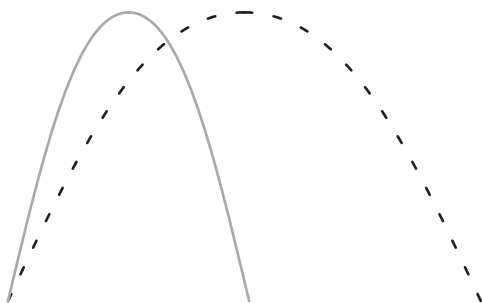
A.



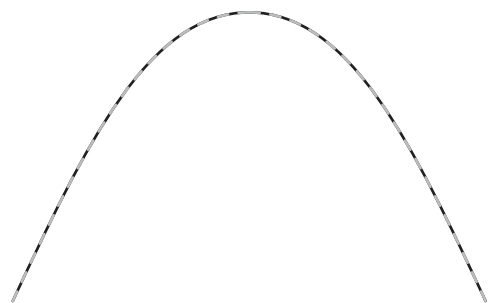
B.



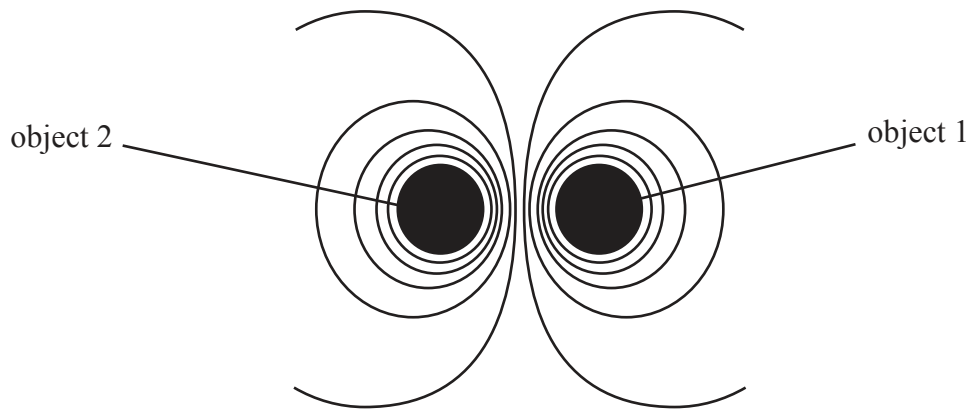
C.



D.



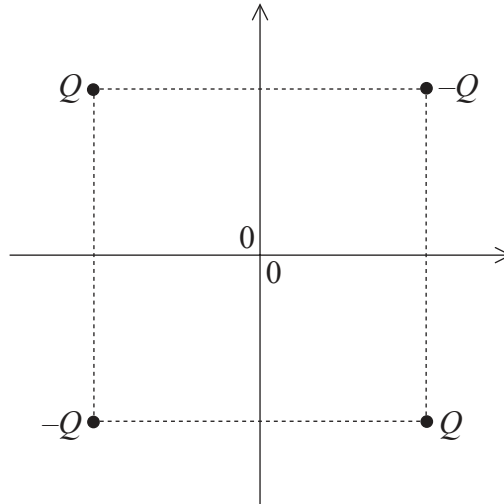
24. The diagram shows equipotential lines due to two objects.



The two objects could be

- A. electric charges of the same sign only.
- B. masses only.
- C. electric charges of opposite sign only.
- D. masses or electric charges of any sign.

25. Two positive and two negative point charges of equal magnitude are placed at the vertices of a square as shown. The origin of the axes is at the centre of the square.

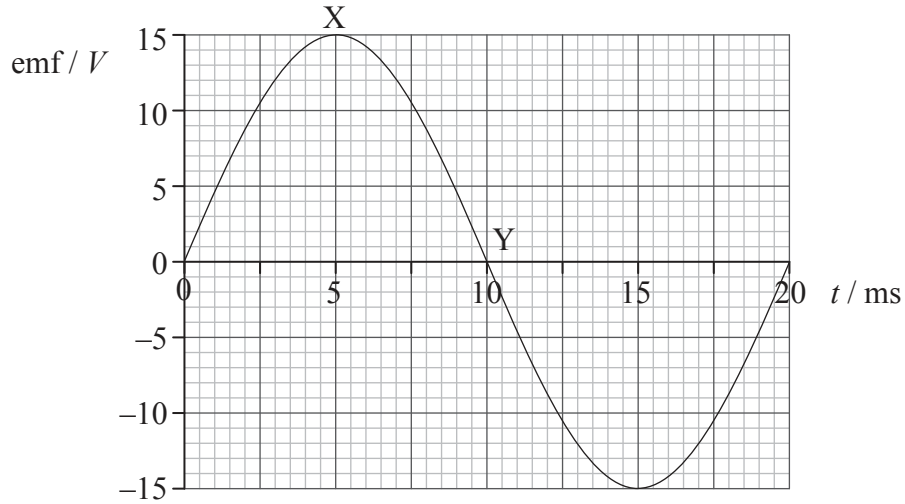


The electric potential is zero

- A. at the origin of the axes only.
- B. along both the  $x$ -axis and the  $y$ -axis.
- C. along the  $y$ -axis only.
- D. along the  $x$ -axis only.

Question 26 and Question 27 both refer to the following.

A rectangular loop of conducting wire rotates in a region of magnetic field. The graph shows the variation with time  $t$  of the induced emf in the loop during one cycle.



26. Which of the following gives the correct times at which the magnitude of the magnetic flux linkage and the magnitude of the current in the loop are maximum?

	Flux linkage	Current
A.	Y	Y
B.	Y	X
C.	X	Y
D.	X	X

27. The resistance of the coil is  $5.0\Omega$ . Which of the following is the average power dissipated in the loop?

- A.  $\frac{45}{2}$  W
- B.  $\frac{45}{\sqrt{2}}$  W
- C. 45 W
- D.  $45\sqrt{2}$  W



28. A radioactive isotope has a half-life of two minutes. A sample contains sixteen grams of the isotope. How much time elapses until one gram of the isotope remains?
- A. 6 minutes
  - B. 8 minutes
  - C. 10 minutes
  - D. 12 minutes
29. The Geiger–Marsden experiment provides evidence for
- A. the existence of discrete atomic energy levels.
  - B. the existence of the neutron.
  - C. a dense positively charged nucleus.
  - D. the stability of some nuclei.
30. The radii of nuclei may be determined by
- A. scattering charged particles off the nuclei.
  - B. injecting the nuclei in a mass spectrometer.
  - C. measuring the de Broglie wavelength of the nuclei.
  - D. observing the spectrum of the nuclei.

31. In the photoelectric effect, the following observations may be made.
- I. The kinetic energy of the emitted electrons increases with increasing light frequency.
  - II. The electrons are emitted without time delay.

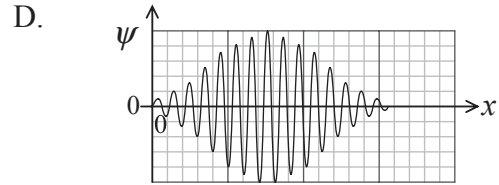
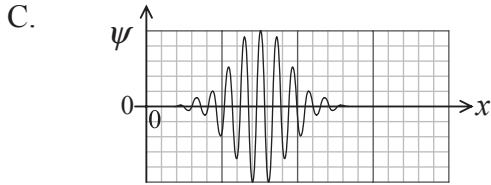
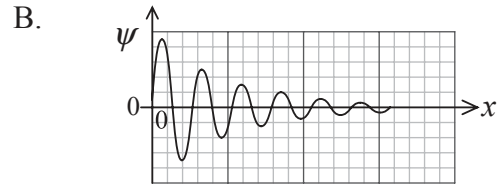
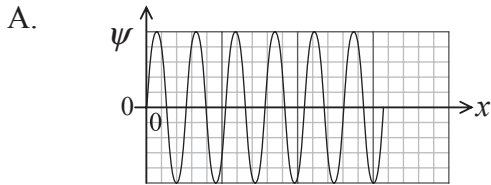
Which of these observations, if any, can be explained in terms of the wave theory of light?

- A. Neither I nor II
  - B. I and II
  - C. I only
  - D. II only
32. A proton and an alpha particle have the same de Broglie wavelength.

Which of the following is approximately the ratio  $\frac{\text{speed of alpha particle}}{\text{speed of proton}}$ ?

- A.  $\frac{1}{4}$
  - B.  $\frac{1}{2}$
  - C. 2
  - D. 4
33. The energies of alpha particles and of gamma-rays emitted in radioactive decay are discrete. This observation is evidence for
- A. atomic energy levels.
  - B. nuclear energy levels.
  - C. nuclei having more neutrons than protons.
  - D. the existence of isotopes.

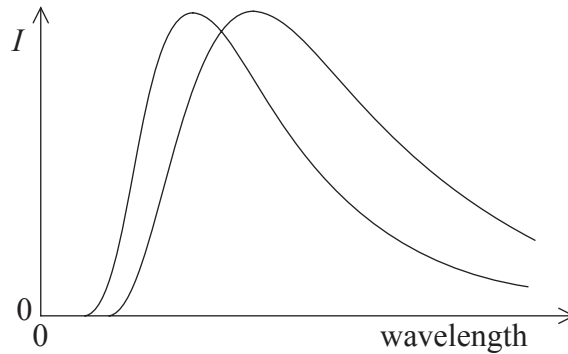
34. The diagrams show the variation with distance  $x$  of the wave function  $\psi$  of four different electrons. The scale on the horizontal axis in all four diagrams is the same. For which electron is the uncertainty in the momentum the largest?



35. A wave generator produces a power per unit length of  $4.0 \text{ kW m}^{-1}$  for waves of amplitude  $A$  and speed  $v$ . The efficiency of the generator is constant. The power per unit length obtained from waves of amplitude  $2A$  and speed  $2v$  would be

- A.  $8.0 \text{ kW m}^{-1}$ .
- B.  $16 \text{ kW m}^{-1}$ .
- C.  $32 \text{ kW m}^{-1}$ .
- D.  $64 \text{ kW m}^{-1}$ .

36. The diagram shows the variation with wavelength of the power per unit wavelength  $I$  radiated from an area of  $1 \text{ m}^2$  of two different bodies.



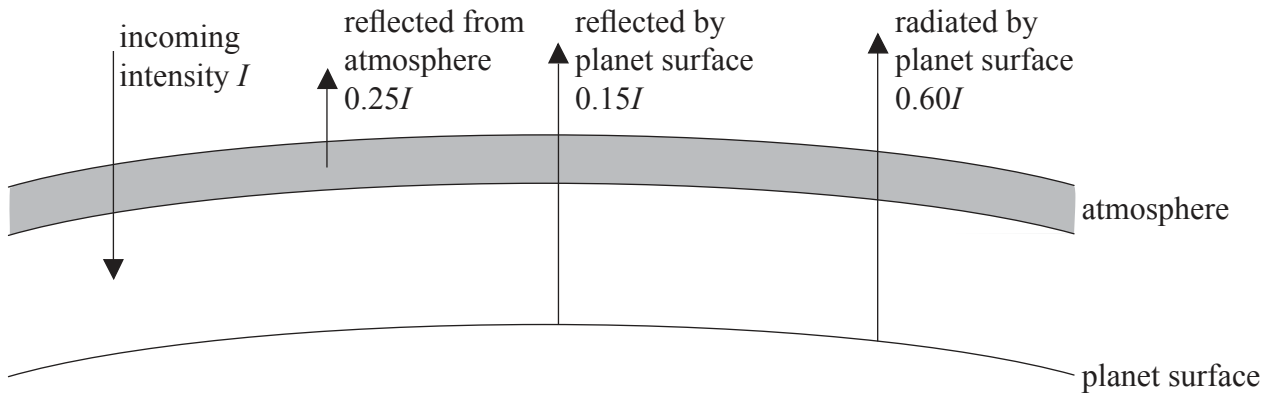
Which of the following is a correct comparison of the temperature and of the emissivity of the two bodies?

	Temperature	Emissivity
A.	same	same
B.	same	different
C.	different	same
D.	different	different

37. Which of the following statements, relating to the production of nuclear power, is correct?

- A. The fuel has high energy density.
- B. Supplies of nuclear fuels are unlimited.
- C. Greenhouse gas emissions are significant.
- D. Waste products are not significant.

38. The diagram shows an energy balance climate model for a planet.



The intensities of the reflected and radiated radiation are given in terms of the incident intensity  $I$ . Which of the following is the albedo of this planet?

- A. 0.15
- B. 0.25
- C. 0.40
- D. 0.60
39. Data are stored on an audio compact disc (CD) at a rate of  $f$  samples per second. Each sample contains  $b$  bits. A total of  $N$  bits are stored on the CD. Which of the following is the playing time of the CD in seconds?
- A.  $\frac{Nf}{b}$
- B.  $\frac{N}{bf}$
- C.  $\frac{bN}{f}$
- D.  $\frac{bf}{N}$

40. Light incident on the pixel of a CCD causes electric charge to collect in the pixel. The amount of charge collected in a given time is proportional to which characteristic of the incident light?
- A. The degree of polarization
  - B. The intensity
  - C. The wavelength
  - D. The frequency
-