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**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Tuesday 4 November 2008 (afternoon)

1 hour

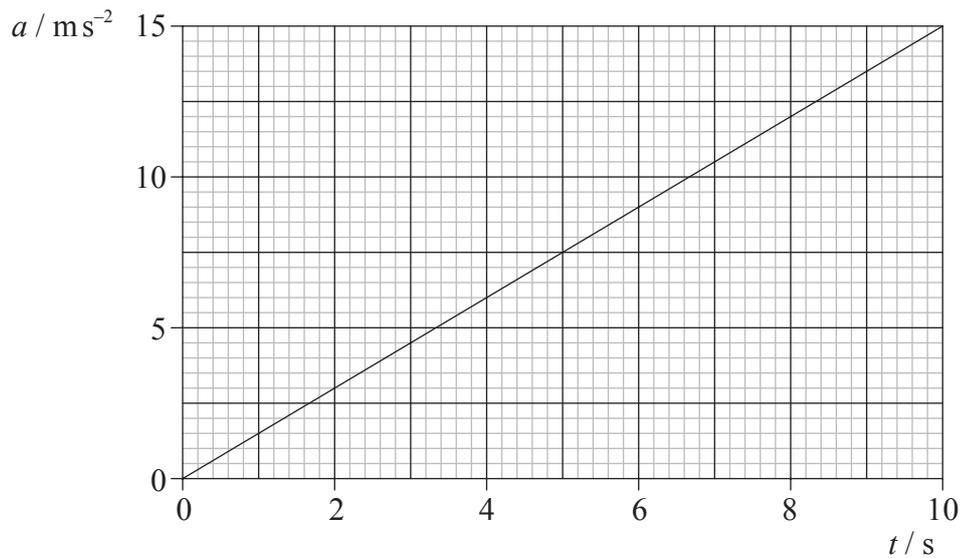
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**INSTRUCTIONS TO CANDIDATES**

- 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. The diameter of a proton is of the order of which of the following?
  - A.  $10^{-12}$  m
  - B.  $10^{-13}$  m
  - C.  $10^{-14}$  m
  - D.  $10^{-15}$  m
  
2. Which of the following is a list of fundamental units only?
  - A. kilogram, mole, kelvin
  - B. kilogram, coulomb, kelvin
  - C. ampere, mole, centigrade
  - D. coulomb, mole, celsius
  
3. The length of each side of a cube of material is measured as 20 mm with an absolute uncertainty of  $\pm 1$  mm. The percentage uncertainty in the calculated volume of the cube is
  - A. 1%.
  - B. 3%.
  - C. 5%.
  - D. 15%.

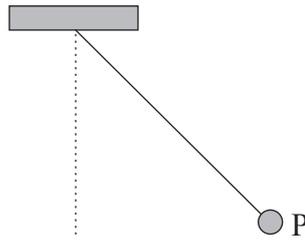
4. The graph shows the variation with time  $t$  of the acceleration  $a$  of a body that starts from rest at  $t=0$ .



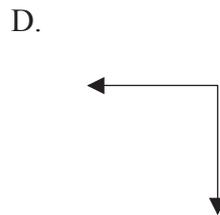
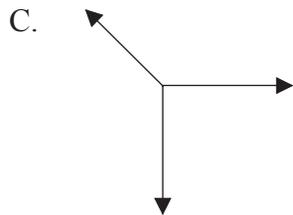
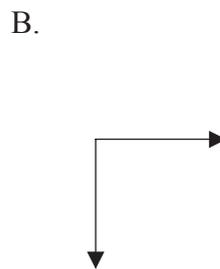
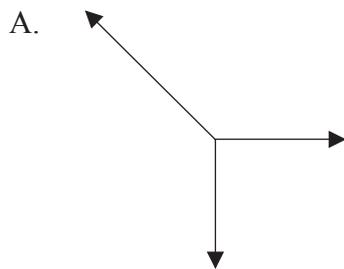
Which of the following is the speed of the object after 10 s?

- A.  $0.67 \text{ ms}^{-1}$
  - B.  $1.5 \text{ ms}^{-1}$
  - C.  $75 \text{ ms}^{-1}$
  - D.  $150 \text{ ms}^{-1}$
5. A feather is dropped from rest at a height of 9.0 m above the surface of the Moon. It takes 3.0 s to reach the surface. Based on this observation, which of the following is the best estimate of the acceleration of free fall at the surface of the Moon?
- A.  $0.50 \text{ ms}^{-2}$
  - B.  $1.0 \text{ ms}^{-2}$
  - C.  $2.0 \text{ ms}^{-2}$
  - D.  $3.0 \text{ ms}^{-2}$

6. A small object P is suspended by a vertical light string. It is then pulled to one side by a force equal in magnitude to the weight of the object and held stationary in the position shown below.

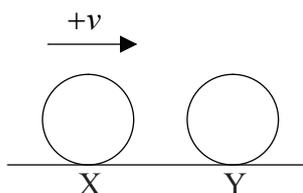


Which of the following is the correct free-body diagram for the forces acting on P in the position shown above?



7. Which of the following is a correct statement of Newton's second law?
- A. The change in momentum of a body is proportional to the external force acting on the body.
  - B. The force acting on a body is equal to the acceleration of the body.
  - C. The rate of change of momentum of a body is equal to the external force acting on the body.
  - D. The force acting on a body is proportional to the mass of the body.

8. A ball X is sliding along a horizontal surface. It collides with an identical ball Y that is at rest.



The velocity of ball X just before the collision is  $+v$ .

Which of the following is a possible velocity of X and of Y immediately after the collision?

	Velocity of X	Velocity of Y
A.	0	$+v$
B.	$-v$	$+v$
C.	$-\frac{v}{2}$	$+\frac{v}{2}$
D.	$-v$	0

9. An insect of weight  $W$  jumps to a vertical height  $h$ . The time from the start of the jump to when the insect leaves the surface is  $t$ . Which of the following is the best estimate for the power generated by the insect to perform the jump?

- A.  $Wht$
- B.  $\frac{Wh}{t}$
- C.  $Whgt$
- D.  $\frac{Wgh}{t}$

10. A model car moves in a horizontal circle of radius  $R$  at constant speed. The mass of the car is  $M$  and it makes one complete revolution in time  $T$ . Which of the following is the magnitude of the net force acting on the car?
- A.  $\frac{4\pi^2 MR}{T^2}$
- B.  $4\pi^2 RMT^2$
- C.  $\frac{2\pi MR}{T}$
- D.  $2\pi MRT$
11. A small spherical planet has radius  $R=2000\text{m}$  and has no atmosphere. The acceleration due to gravity on the surface of this planet is  $2.0\text{ms}^{-2}$ . At an altitude of  $3000\text{m}$  above the surface of the planet the magnitude of the gravitational field strength is
- A. zero.
- B. between  $0$  and  $2.0\text{Nkg}^{-1}$ .
- C. equal to  $2.0\text{Nkg}^{-1}$ .
- D. is greater than  $2.0\text{Nkg}^{-1}$ .
12. A projectile is fired from the top of a cliff at an angle to the horizontal. Air resistance is negligible. Which of the following is constant during its flight?
- A. Vertical component of velocity
- B. Horizontal component of velocity
- C. Potential energy
- D. Kinetic energy

13. A satellite in orbit about Earth moves to another orbit that is closer to the surface of Earth. Which of the following is a correct statement about the change in speed of the satellite and its change in potential energy?

	Change in speed	Change in potential energy
A.	decreases	decreases
B.	decreases	increases
C.	increases	increases
D.	increases	decreases

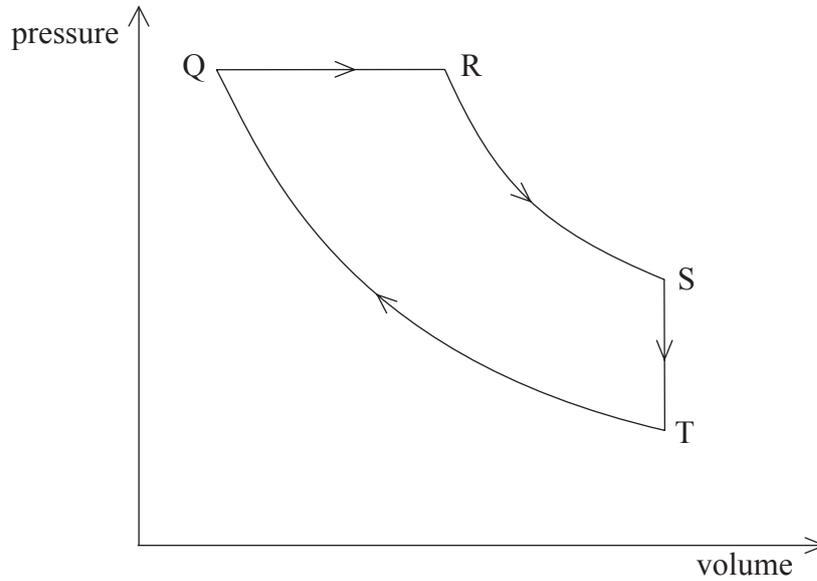
14. A block is sliding along a surface. Which of the following factors has minimal effect on the frictional force acting between the block and the surface?
- A. The area of contact between the block and the surface.
  - B. The normal force between the block and the surface.
  - C. The material from which the block is made.
  - D. The presence of lubricants between the block and the surface.
15. The distance between the Earth and the Sun is  $d$ . The gravitational force of the Sun on the Earth is  $F$ . Which of the following is the torque exerted on the Earth about an axis through the centre of the Sun?
- A. 0
  - B.  $Fd$
  - C.  $\frac{F}{d}$
  - D.  $\frac{F}{d^2}$

16. Two spherical planets X and Y are of uniform density and have equal mass. The radius of X is twice that of Y. The minimum kinetic energy needed by a body to escape from the surface of planet X is  $K_x$ . Which of the following is the minimum kinetic energy needed by the same body to escape from the surface of planet Y?
- A.  $0.25 K_x$
  - B.  $0.5 K_x$
  - C.  $2 K_x$
  - D.  $4 K_x$
17. A lump of ice at  $0^\circ\text{C}$  is placed into water at  $0^\circ\text{C}$ . Assuming that no thermal energy is lost to the surroundings, which of the following statements is true regarding the melting of the ice and the temperature change?

	<b>Melting of ice</b>	<b>Temperature change</b>
A.	some of the ice will melt	the overall temperature of the water will initially fall before going back to $0^\circ\text{C}$
B.	some of the ice will melt	the overall temperature of the water will remain the same
C.	none of the ice will melt	the temperature of the ice and water will remain the same
D.	none of the ice will melt	the overall temperature of the water will fall

18. An isolated container is divided into two equal volumes by a partition. In each part of the container there is an ideal gas. They have the same pressure  $P$ . The partition is removed. Which of the following is the final pressure?
- A.  $\frac{P}{2}$
  - B.  $P$
  - C.  $\frac{3P}{2}$
  - D.  $2P$

19. The diagram below shows the relation between the pressure and the volume of the gas in an engine for one cycle of operation of the engine.

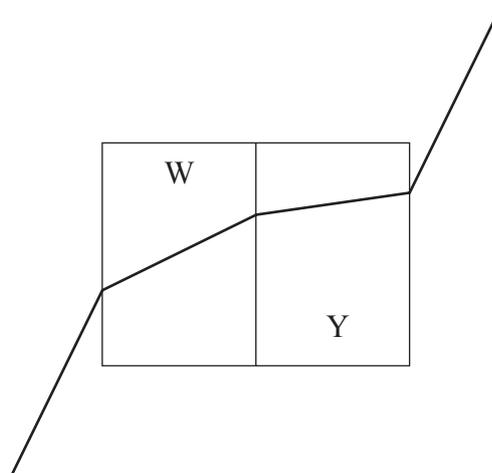


Work is done by the gas in the engine during

- A.  $Q \rightarrow R$  only.
  - B.  $Q \rightarrow R$  and  $R \rightarrow S$ .
  - C.  $S \rightarrow T$  only.
  - D.  $S \rightarrow T$  and  $Q \rightarrow R$ .
20. A Carnot engine is in contact with a reservoir X at kelvin temperature  $2T$  and another reservoir at temperature  $T$ . The temperature of X is increased to  $4T$ . The efficiency of the engine will
- A. decrease by a factor of 2.
  - B. increase by a factor of 2.
  - C. decrease by a factor of 1.5.
  - D. increase by a factor of 1.5.

21. A transverse wave is moving along a string. Two points on the string are separated by half a wavelength. The velocities of these points are always
- A. constant.
  - B. in a direction parallel to the direction of propagation of the wave.
  - C. opposite to each other.
  - D. the same as each other.

22. A light ray travels from a vacuum into two transparent rectangular blocks. The blocks have refractive indices  $W$  and  $Y$ .



Which of the following is true?

- A.  $Y < W < 1$
- B.  $Y < 1 < W$
- C.  $W < 1 < Y$
- D.  $1 < W < Y$

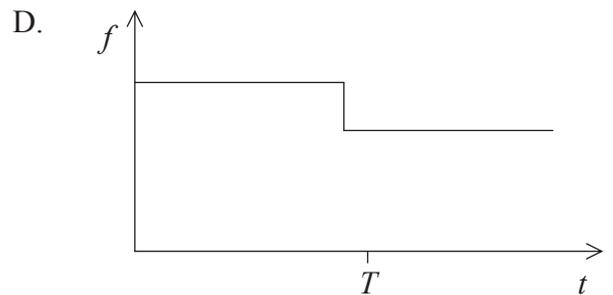
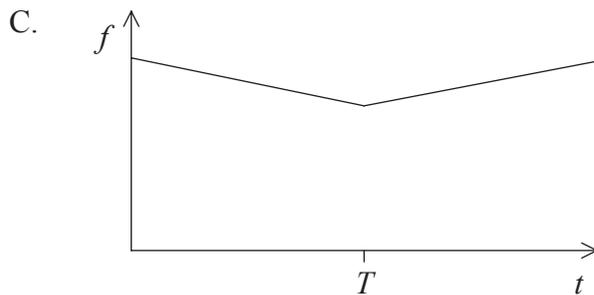
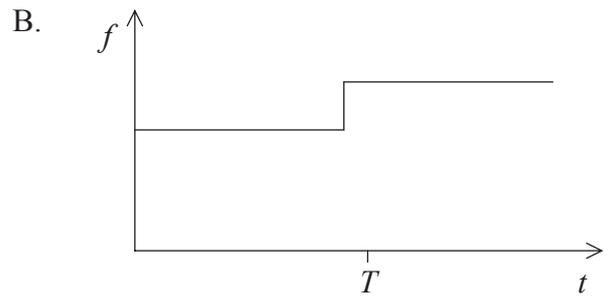
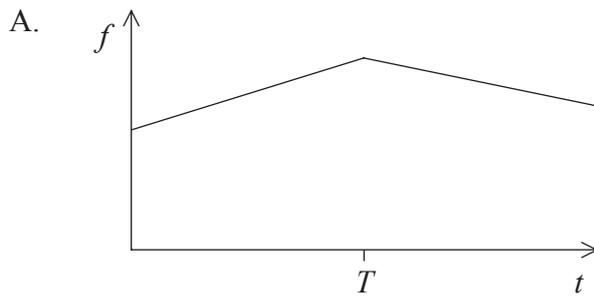
23. The fundamental mode of a vibrating string has frequency  $f$  and wavelength  $\lambda$ . Which of the following gives the correct frequency and wavelength for the fundamental mode of an identical string of half the length and the same tension?

	Frequency	Wavelength
A.	$2f$	$\frac{\lambda}{2}$
B.	$2f$	$2\lambda$
C.	$\frac{f}{2}$	$2\lambda$
D.	$\frac{f}{2}$	$\frac{\lambda}{2}$

24. A railway engine, travelling at a constant speed on a straight level track is sounding its whistle. The whistle emits a sound of constant frequency. The engine approaches a station platform and passes an observer O standing on the platform at time  $t = T$ .



Which of the following sketch graphs best shows the variation with time  $t$  of the frequency  $f$  of the sound heard by O?

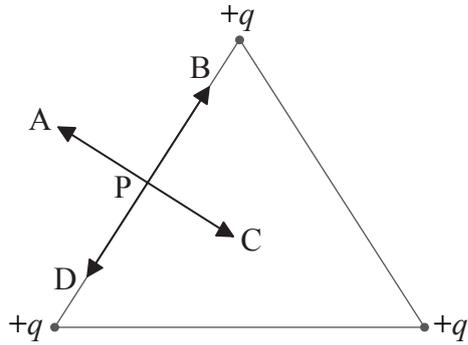


25. The outputs of two signal generators X and Y are each connected to a separate loudspeaker. The frequency of X is 442 Hz. The combined sound heard from both speakers has a frequency 444 Hz with a beat frequency of 4.00 Hz.

The frequency of Y is

- A. 438 Hz.
  - B. 440 Hz.
  - C. 444 Hz.
  - D. 446 Hz.
26. In a Young's double slit experiment the width of the slits is small compared to the separation of the slits. This ensures that
- A. the slits act as coherent sources.
  - B. the light incident on the screen is of sufficient intensity to produce visible fringes.
  - C. the fringes on the screen are well separated.
  - D. diffraction effects are significant.

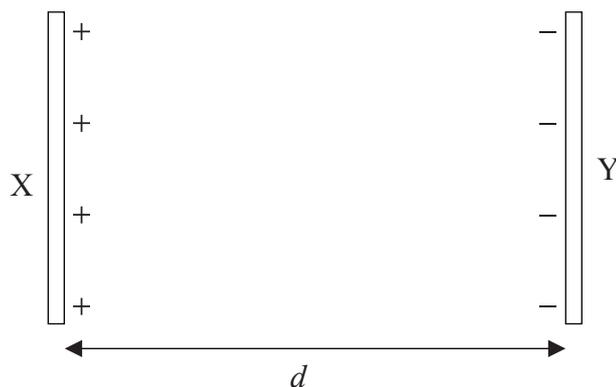
27. Three point charges  $+q$  are held at the vertices of a triangle. Each side of the triangle has the same length.



Which arrow shows the direction of the electric field at point P?

- A. A
- B. B
- C. C
- D. D

28. The diagram below shows two charged parallel plates X and Y in a vacuum. X is positively charged and Y is negatively charged. The distance between the plates is  $d$ .

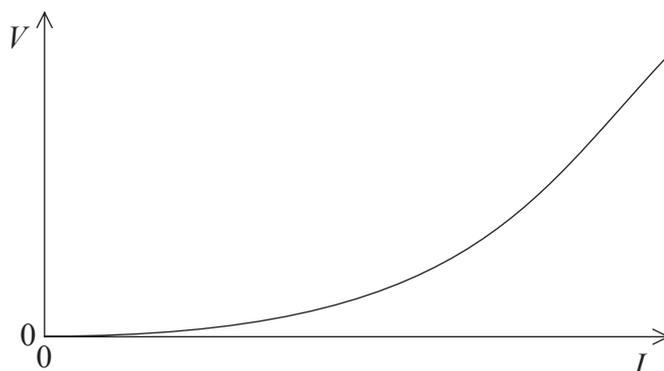


The magnitude of the charge on each plate is the same. A particle with charge  $+q$  is accelerated from rest from plate X to plate Y. The kinetic energy of the particle when it reaches Y is  $K$ .

Which of the following is a correct expression for the magnitude of the electric field strength between plates X and Y?

- A.  $\frac{K}{qd}$
- B.  $\frac{Kd}{q}$
- C.  $\frac{qd}{K}$
- D.  $\frac{q}{Kd}$

29. The graph shows the variation with the current  $I$  in a filament lamp of the potential difference  $V$ .



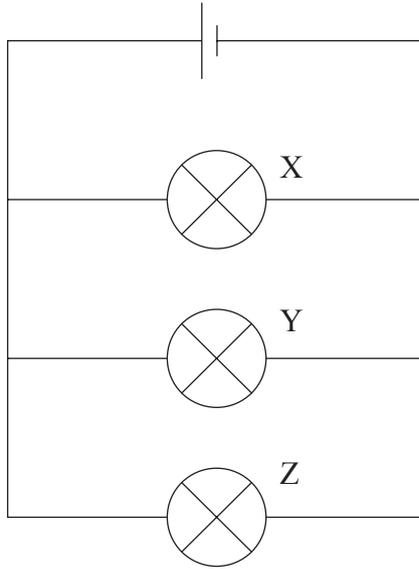
Which of the following is correct regarding the resistance of the filament and its temperature as the current is increasing in the filament?

	<b>Resistance</b>	<b>Temperature</b>
A.	equals $\frac{V}{I}$ at any point	increasing
B.	equals $\frac{V}{I}$ at any point	constant
C.	equals gradient of graph	increasing
D.	equals gradient of graph	constant

30. Two long, parallel wires are separated by a distance of 1.0m. The current in each wire is 1.0A. Which of the following is the magnitude of the force on 1.0m length of each wire?

- A.  $2\pi \times 10^7 \text{ N}$
- B.  $2 \times 10^7 \text{ N}$
- C.  $2\pi \times 10^{-7} \text{ N}$
- D.  $2 \times 10^{-7} \text{ N}$

31. Three identical filament lamps X, Y and Z are connected in a circuit as shown. Each lamp is operating at normal brightness.

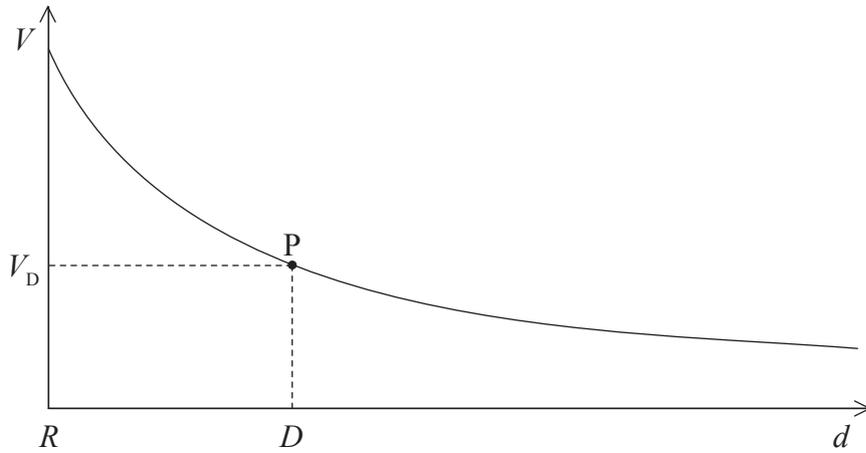


The cell has negligible internal resistance. The filament of lamp Y breaks such that its resistance becomes infinite.

Which of the following correctly gives the change in brightness, if any, of the lamps X and Z?

	<b>Brightness of lamp X</b>	<b>Brightness of lamp Z</b>
A.	increases	stays the same
B.	stays the same	stays the same
C.	increases	increases
D.	stays the same	increases

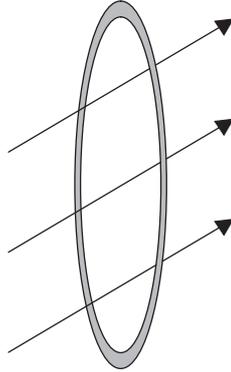
32. The sketch graph shows the variation with the distance  $d$  from the centre of a charged sphere of potential  $V$ . The radius of the sphere is  $R$ .



The magnitude of the electric field strength at a point  $P$  a distance  $D$  from the centre may be defined as

- A.  $\frac{V_D}{D}$ .
- B.  $\frac{V_D}{D^2}$ .
- C. the gradient of the graph at  $P$ .
- D.  $\frac{\text{the gradient of the graph at } P}{D}$ .

33. A time-changing magnetic field links a conducting coil and acts at an angle to the plane of the conducting coil.



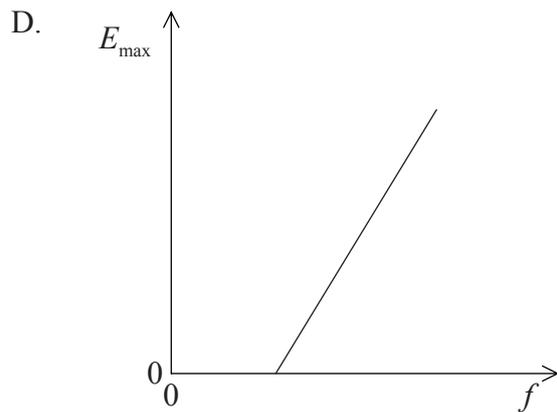
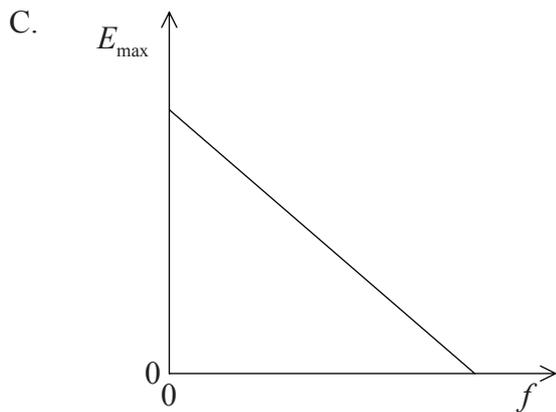
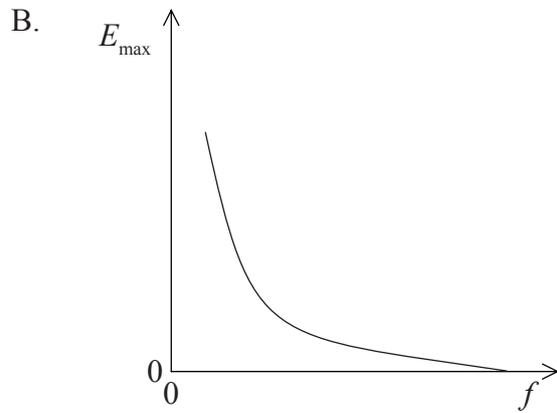
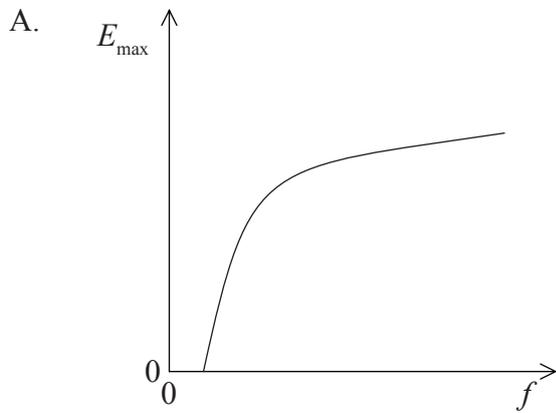
The e.m.f. induced in the coil is equal to

- A. zero.
  - B. the rate of change of the magnitude of the magnetic field strength.
  - C. the magnitude of the flux linking the coil.
  - D. the rate of change of magnetic flux linkage.
34. A resistor is connected in series with a sinusoidal a.c. supply of negligible internal resistance. The maximum value of the e.m.f of the supply is  $V_0$ . The maximum power dissipated in the resistor is  $P_0$ . Which of the following is the maximum current in the resistor?

- A.  $\frac{P_0}{\sqrt{2}V_0}$
- B.  $\frac{P_0}{2V_0}$
- C.  $\frac{P_0}{V_0}$
- D.  $\frac{\sqrt{2}P_0}{V_0}$

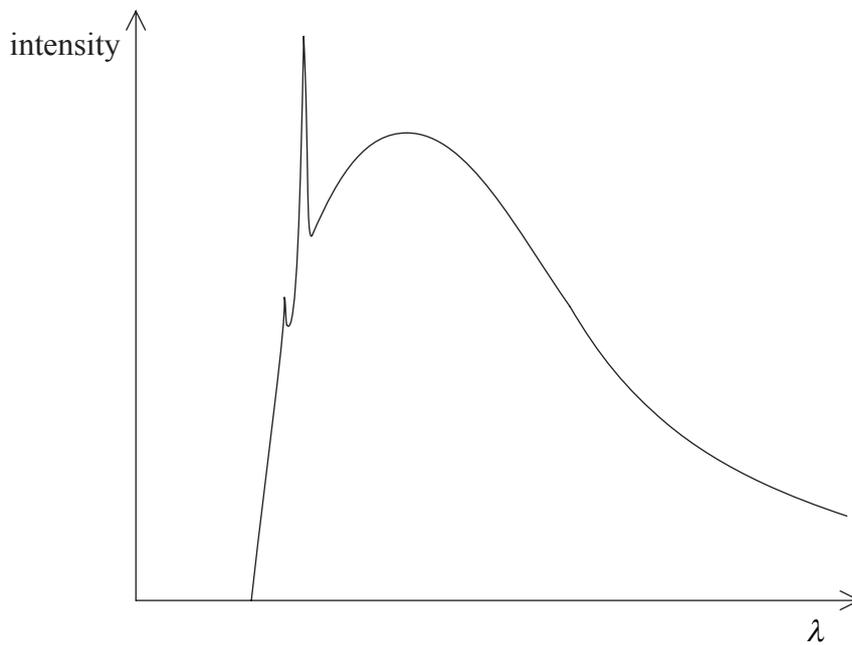
35. Which of the following gives evidence to support the existence of atomic energy levels?
- A.  $\alpha$ -particle scattering
  - B. Absorption spectra
  - C. The existence of isotopes
  - D.  $\beta$ -decay

36. Light of frequency  $f$  is incident on a clean metal surface. The maximum energy of the electrons emitted from the surface is  $E_{\max}$ . Which of the following sketch-graphs best shows the variation with  $f$  of  $E_{\max}$ ?



37. Which of the following provides evidence for the existence of nuclear energy levels?
- A. Scattering of electrons from the surface of a crystal.
  - B. Characteristic X-ray spectra.
  - C.  $\alpha$ -particle scattering.
  - D. The discrete nature of the  $\gamma$ -ray spectra in radioactive decay.

38. The diagram below shows a sketch of the X-ray spectrum produced when electrons strike a heavy metal target.



The energy of the electrons incident on the metal is now increased.

Which of the following correctly describes the effect this will have on the minimum X-ray wavelength and the wavelengths of the characteristic spectra?

	<b>Minimum X-ray wavelength</b>	<b>Wavelengths of characteristic spectra</b>
A.	no change	no change
B.	decreases	no change
C.	no change	decreases
D.	decreases	decreases

39. Uranium-238 is known to have a half-life of several thousand years. Which of the following quantities need to be measured in order to determine the half-life of a sample of uranium-238?
- A. The mass and the activity.
  - B. The mass only.
  - C. The activity only.
  - D. The mass and the time it takes for the initial mass to reduce by half.
40. The two classes of hadrons are
- A. leptons and bosons.
  - B. mesons and baryons.
  - C. mesons and leptons.
  - D. bosons and mesons.
-