



**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Monday 10 May 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.

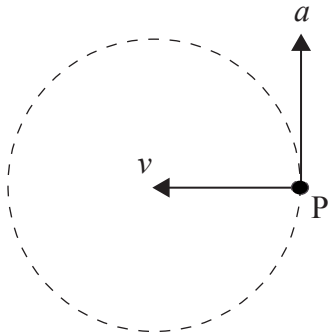
1. The best estimate for the time it takes light to cross the nucleus of the hydrogen atom is
  - A.  $10^{-23}$  s.
  - B.  $10^{-20}$  s.
  - C.  $10^{-15}$  s.
  - D.  $10^{-7}$  s.
  
2. The length of each side of a sugar cube is measured as 10 mm with an uncertainty of  $\pm 2$  mm. Which of the following is the absolute uncertainty in the volume of the sugar cube?
  - A.  $\pm 6 \text{ mm}^3$
  - B.  $\pm 8 \text{ mm}^3$
  - C.  $\pm 400 \text{ mm}^3$
  - D.  $\pm 600 \text{ mm}^3$
  
3. Which of the following quantities can be determined from a speed-time graph of a particle travelling in a straight line?
  - A. Only the magnitude of the acceleration at a given instant
  - B. Both the velocity and the acceleration at a given instant
  - C. Only the distance travelled in a given time
  - D. Both the distance travelled in a given time and the magnitude of the acceleration at a given instant
  
4. Which of the following is a correct statement of Newton's second law of motion?
  - A. A force acting on a body is proportional to the mass of the body.
  - B. The rate of change of momentum of a body is equal to the net external force acting on the body.
  - C. The momentum of a body is proportional to the net external force acting on the body.
  - D. A force acting on a body is proportional to the acceleration of the body.

5. Which of the following is a correct definition of work?
- A. Product of force and distance
  - B. Product of force and distance moved in the direction of the force
  - C. Product of power and time
  - D. Product of force and displacement

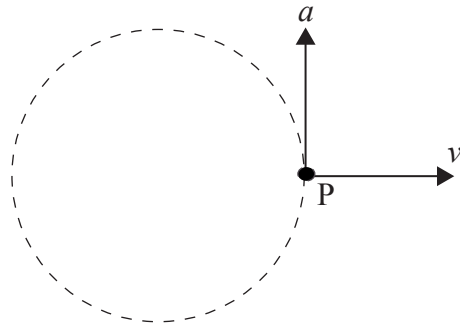
6. A particle P is moving anti-clockwise with constant speed in a horizontal circle.

Which diagram correctly shows the direction of the velocity  $v$  and acceleration  $a$  of the particle P in the position shown?

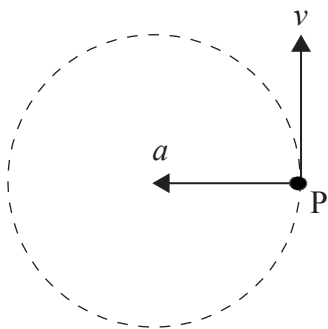
A.



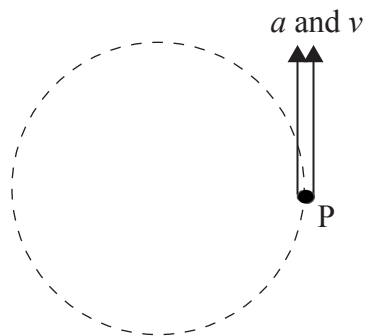
B.



C.



D.



7. The diagram shows two parallel metal plates X and Y.

$$V = + V_0$$

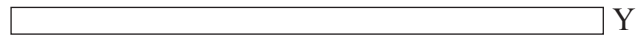


Plate X is at Earth potential (0 V) and the potential of plate Y is  $V_0$ .

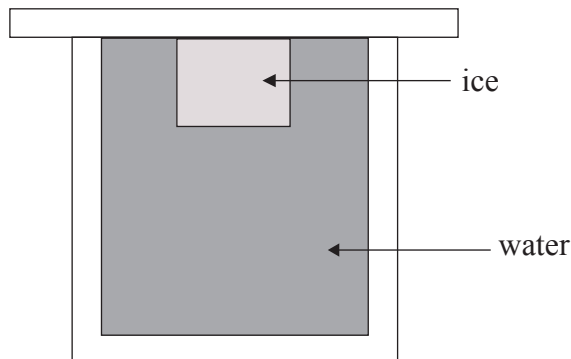
Which of the following is correct in respect of the magnitude and the direction of the electric field between the plates?

	<b>Magnitude</b>	<b>Direction</b>
A.	constant	$X \rightarrow Y$
B.	increasing	$Y \rightarrow X$
C.	constant	$Y \rightarrow X$
D.	increasing	$X \rightarrow Y$

8. Gravitational potential at a point is defined as the work done

- A. per unit mass in moving a small mass from infinity to the point.
- B. in moving a unit mass from infinity to the point.
- C. in moving a small mass from infinity to the point.
- D. per unit mass in moving a unit mass from infinity to the point.

9. The escape speed from the surface of a planet depends on
- A. both the radius and the mass of the planet.
  - B. only the radius of the planet.
  - C. only the mass of the planet.
  - D. only the gravitational field strength at the surface of the planet.
10. Water at a temperature of  $0^{\circ}\text{C}$  is kept in a thermally insulated container. A lump of ice, also at  $0^{\circ}\text{C}$ , is placed in the water and completely submerged.

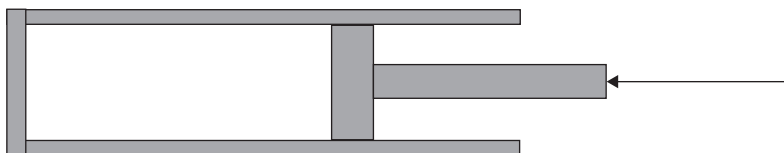


Which of the following is true in respect of both the net amount of ice that will melt and the change in temperature of the water?

	<b>Net amount of ice that melts</b>	<b>Change in temperature of water</b>
A.	all will melt	no change
B.	some will melt	decrease
C.	none will melt	no change
D.	all will melt	decrease

11. The mole is defined as
- A.  $\frac{1}{12}$  the mass of an atom of the isotope carbon-12.
  - B. the amount of a substance that contains as many elementary entities as the number of atoms in 12 g of the isotope carbon-12.
  - C. the mass of one atom of the isotope carbon-12.
  - D. the amount of a substance that contains as many nuclei as the number of nuclei in 12 g of the isotope carbon-12.

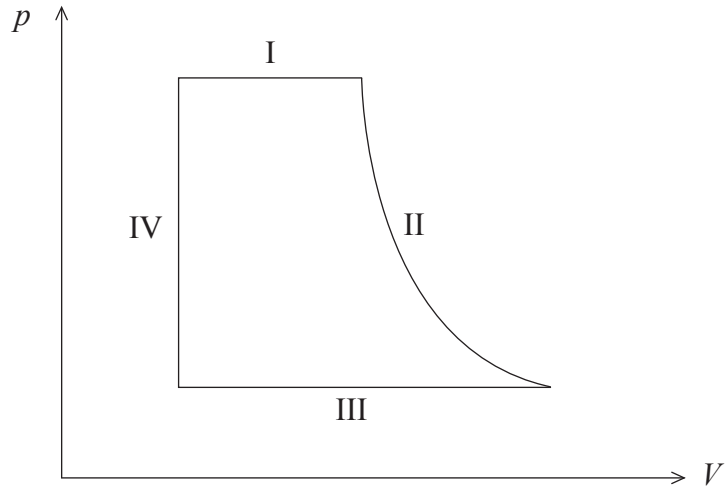
12. A gas is contained in a cylinder by a piston.



The gas is compressed rapidly by moving the piston in the direction shown. The best explanation for the resulting increase in temperature of the gas is that the molecules of the gas gain kinetic energy

- A. from the moving piston.
  - B. by colliding more frequently with each other.
  - C. by being pushed closer together.
  - D. by colliding more frequently with the walls of the cylinder.
13. The behaviour of a monatomic gas such as helium will approximate to that of an ideal gas when it is kept at
- A. a temperature close to absolute zero.
  - B. low pressure.
  - C. very high pressure.
  - D. very high temperature.

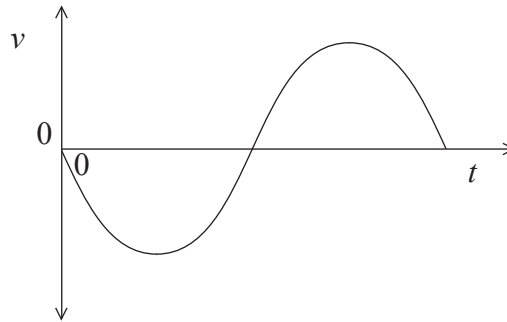
14. The diagram shows the pressure  $p$  and volume  $V$  relationship for one cycle of operation of an engine.



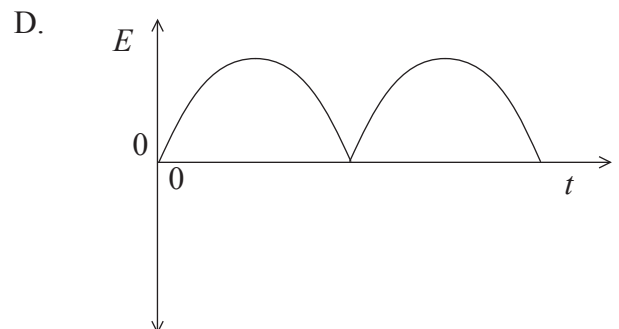
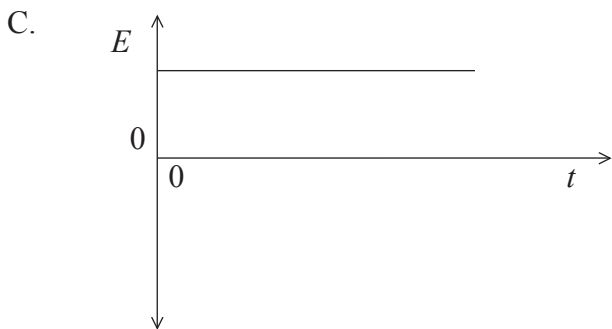
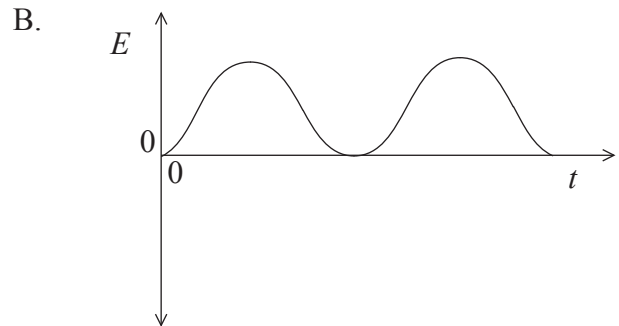
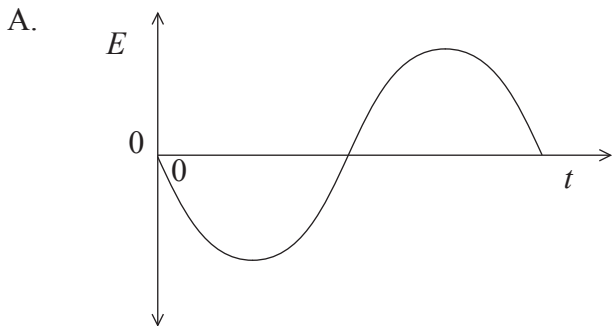
Which of the labelled parts of the cycle identify isobaric changes and adiabatic changes of state?

	<b>Isobaric</b>	<b>Adiabatic</b>
A.	IV only	I and II only
B.	I and III only	II and IV only
C.	II and III only	IV only
D.	I and III only	II only

15. The graph shows how the velocity  $v$  of an object undergoing simple harmonic motion varies with time  $t$  for one complete period of oscillation.



Which of the following sketch graphs best shows how the total energy  $E$  of the object varies with  $t$ ?



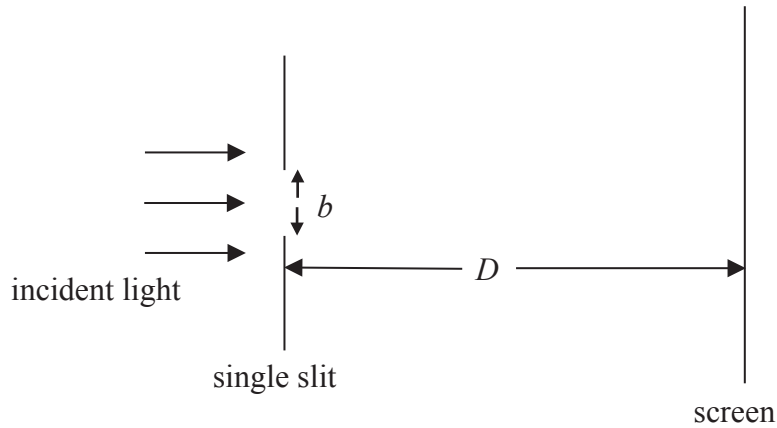
16. A force that varies sinusoidally is applied to a system that is lightly damped. Which of the following must be true of the force for resonance to occur?

- A. It must always be in anti-phase with the oscillations of the system.
- B. Its direction must always be in the direction of motion of the oscillations of the system.
- C. Its frequency must be equal to the frequency of oscillation of the system.
- D. Its amplitude must be equal to the amplitude of oscillation of the system.



17. Which of the following is a value of wavelength that is found in the visible region of the electromagnetic spectrum?
- A.  $4 \times 10^{-5}$  m
  - B.  $4 \times 10^{-7}$  m
  - C.  $4 \times 10^{-9}$  m
  - D.  $4 \times 10^{-11}$  m
18. The fundamental (first harmonic) frequency of the note emitted by an organ pipe closed at one end is  $f$ . What is the fundamental frequency of the note emitted by an organ pipe of the same length that is open at both ends?
- A.  $\frac{f}{4}$
  - B.  $\frac{f}{2}$
  - C.  $2f$
  - D.  $4f$
19. Which of the following wave phenomena is associated with blood flow measurements?
- A. Polarization
  - B. Diffraction
  - C. Refraction
  - D. Doppler effect

20. A beam of coherent light is incident on a single slit of width  $b$ . After passing through the slit, the light is incident on a screen at a distance  $D$  from the slit.



Which of the following changes, carried out separately, in respect of  $b$  and  $D$  will result in an increase in width of the first diffraction maximum formed on the screen?

	$b$	$D$
A.	decrease	increase
B.	increase	increase
C.	decrease	decrease
D.	increase	decrease

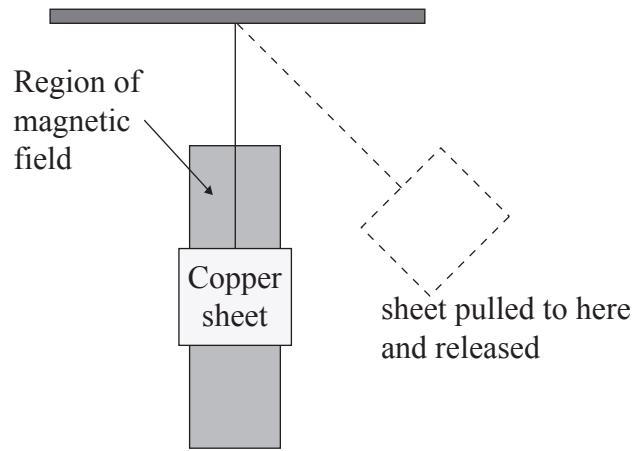
21. The images of two sources are just resolved. Which of the following is a correct statement of the Rayleigh criterion for this situation?
- A. The central maximum of the diffraction pattern of one source must coincide with the central maximum of the diffraction pattern of the other source.
  - B. Light from the sources must pass through a circular aperture.
  - C. Light from the sources must be coherent.
  - D. The first minimum of the diffraction pattern of one source must coincide with the central maximum of the diffraction pattern of the other source.

22. An optically active substance is a substance that
- A. has a refractive index that depends on the plane of polarization of incident light.
  - B. completely absorbs incident unpolarized light.
  - C. rotates the plane of polarization of incident polarized light.
  - D. polarizes unpolarized light.
23. The electromotive force (emf) of a cell is defined as
- A. the power supplied by the cell per unit current from the cell.
  - B. the force that the cell provides to drive electrons round a circuit.
  - C. the energy supplied by the cell per unit current from the cell.
  - D. the potential difference across the terminals of the cell.
24. The weight of an object of mass 1 kg at the surface of Mars is about 4 N. The radius of Mars is about half the radius of Earth. Which of the following is the best estimate of the ratio below?

$$\frac{\text{mass of Mars}}{\text{mass of Earth}}$$

- A. 0.1
- B. 0.2
- C. 5
- D. 10

25. A copper sheet is suspended in a region of uniform magnetic field by an insulating wire connected to a horizontal support. The sheet is pulled to one side so that it is outside the region of the field, and then released.

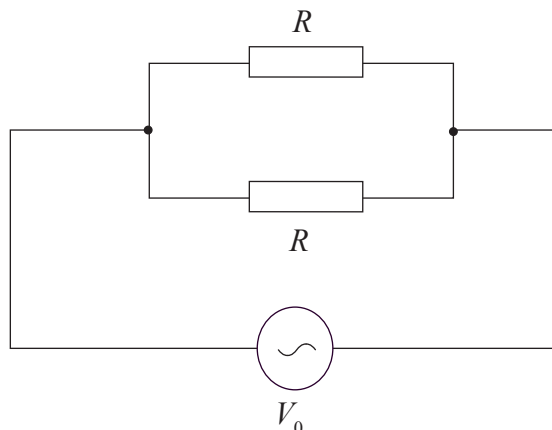


The uniform magnetic field is directed into the plane of the paper.

Which of the following is true for both the direction of the induced current in the sheet and the change in amplitude of the oscillations of the sheet with time?

	<b>Direction of induced current</b>	<b>Change in amplitude</b>
A.	stays the same	no change
B.	changes	decreases
C.	stays the same	decreases
D.	changes	no change

26. An alternating current supply of negligible internal resistance is connected to two resistors that are in parallel.



The resistance of each resistor is  $R$  and the peak voltage of the ac supply is  $V_0$ . Which of the following is the average power dissipated in the circuit?

- A.  $\frac{2V_0^2}{R}$
- B.  $\frac{V_0^2}{R}$
- C.  $\frac{V_0^2}{\sqrt{2}R}$
- D.  $\frac{V_0^2}{2R}$
27. Which of the following is true in respect of both the Coulomb interaction and the strong interaction between nucleons in an atom?

	<b>Coulomb interaction exists between</b>	<b>Strong interaction exists between</b>
A.	protons only	neutrons only
B.	both protons and neutrons	neutrons only
C.	protons only	both protons and neutrons
D.	both protons and neutrons	both protons and neutrons

28. Light of frequency  $f$  is incident on a metal surface. The work function of the metal is  $\phi$ . Which of the following is the maximum kinetic energy of the electrons emitted from the surface?

- A.  $hf - \phi$
- B.  $\frac{h}{e}(f - \phi)$
- C.  $\phi - hf$
- D.  $\frac{h}{e}(\phi - f)$

29. An electron is accelerated from rest through a potential difference  $V$ .

Which of the following is the de Broglie wavelength of the electron after acceleration?

- A.  $\frac{h}{\sqrt{2m_e V e}}$
- B.  $\sqrt{\frac{2m_e h}{V^2}}$
- C.  $\frac{h}{2m_e V^2 e^2}$
- D.  $\frac{V^2}{2m_e h}$

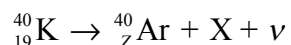
30. Which of the following is an assumption of the Schrödinger model of the hydrogen atom?

- A. The orbital path of the electron fits a standing wave.
- B. The position of the electron is undefined but its momentum is well defined.
- C. The momentum of the electron is undefined but its position is well defined.
- D. The electron is described by wavefunctions.

31. A Bainbridge mass spectrometer may be used to measure the mass of

- A. an atom.
- B. an ion.
- C. an isotope.
- D. a molecule.

32. A nucleus of the isotope potassium-40 decays to a nucleus of the isotope argon-40. The reaction equation for this decay may be written as



Which of the following correctly identifies the proton number of argon-40 and the particle X?

	<b>Z</b>	<b>X</b>
A.	18	$\beta^-$
B.	18	$\beta^+$
C.	19	$\beta^+$
D.	19	$\beta^-$

33. For the five-bit binary number 11010, which of the following correctly identifies both the most-significant bit (MSB) and the equivalent decimal number?

	<b>MSB</b>	<b>Decimal</b>
A.	1	52
B.	0	26
C.	1	26
D.	0	52

34. The capacitance of a pixel of a CCD is 3.2 pF. A pulse of light is incident on the pixel and as a result,  $10^4$  electrons are ejected from the pixel. The magnitude of the change in potential of the pixel is
- A.  $5.0 \times 10^{-16}$  V
  - B.  $5.0 \times 10^{-4}$  V
  - C.  $2.0 \times 10^3$  V
  - D.  $2.0 \times 10^{15}$  V
35. Which of the following ratios is the definition of quantum efficiency of a pixel?
- A.  $\frac{\text{number of photons incident}}{\text{number of electrons emitted}}$
  - B.  $\frac{\text{number of electrons emitted}}{\text{number of photons incident}}$
  - C.  $\frac{\text{intensity of incident light}}{\text{intensity of emitted light}}$
  - D.  $\frac{\text{intensity of emitted light}}{\text{intensity of incident light}}$
36. Degraded energy is energy that is
- A. stored in the Earth's atmosphere.
  - B. available from non-renewable energy sources.
  - C. converted into work in a cyclical process.
  - D. no longer available for the performance of useful work.



37. A coal-fired power station has a power output of  $P$  and its efficiency is  $\varepsilon$ . It burns a mass of coal  $M$  every second. The best estimate of the energy density of the coal used is

- A.  $P\varepsilon M$
- B.  $\frac{M\varepsilon}{P}$
- C.  $\frac{P\varepsilon}{M}$
- D.  $\frac{P}{\varepsilon M}$

38. Which of the following correctly describes both the role of the moderator and of the control rods in a nuclear reactor?

	<b>Moderator</b>	<b>Control rods</b>
A.	slows down the neutrons	maintain a constant rate of fission
B.	cools down the reactor	extract thermal energy
C.	cools down the reactor	maintain a constant rate of fission
D.	slows down the neutrons	extract thermal energy

39. Which of the following correctly shows the energy change in a photovoltaic cell and in a solar heating panel?

	<b>Photovoltaic cell</b>	<b>Solar heating panel</b>
A.	solar → electrical	solar → thermal
B.	electrical → thermal	solar → electrical
C.	solar → electrical	electrical → thermal
D.	electrical → thermal	solar → thermal

40. The albedo for the oceans is lower than that for glaciers. This is because, compared to ice, sea water
- A. has a greater density.
  - B. has a greater specific heat capacity.
  - C. has a greater coefficient of volume expansion.
  - D. absorbs a greater amount of radiative power.
-