



**PHYSICS
HIGHER LEVEL
PAPER 1**

Tuesday 12 May 2009 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

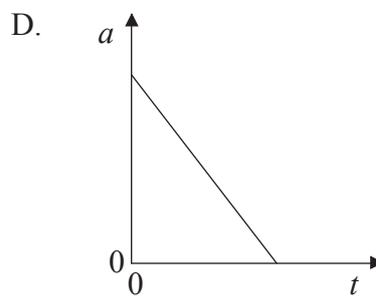
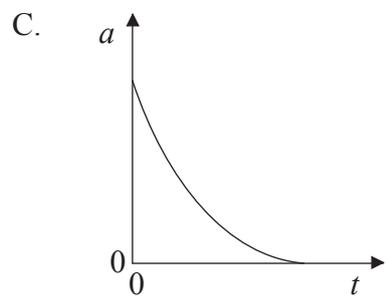
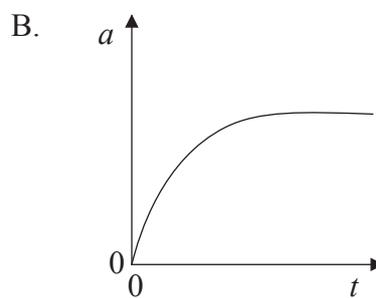
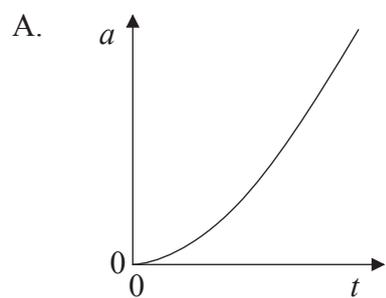
- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.



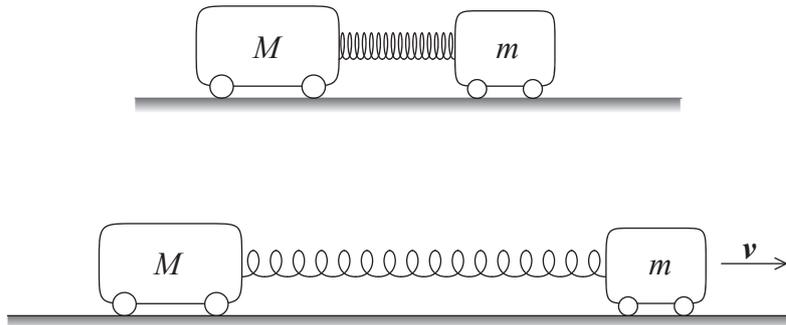
1. The magnitude of the mass of the universe is of the order of

- A. 10^{20} kg.
- B. 10^{30} kg.
- C. 10^{40} kg.
- D. 10^{50} kg.

2. A ball, initially at rest, is dropped in the air from a great height. Air resistance is not negligible. Which of the following graphs best shows the variation with time t of the acceleration a of the ball?

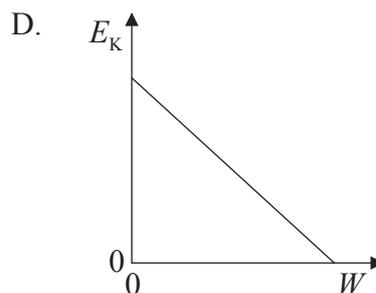
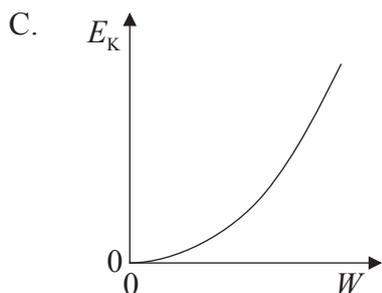
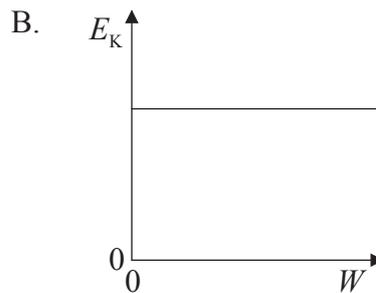
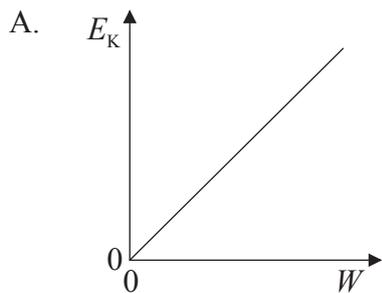


3. Two carts of different mass m and M are connected by a spring. They are pushed together such that the spring is compressed.

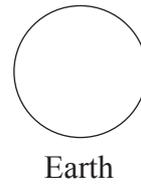


After the carts are released, the cart of mass m moves with velocity v . The change in the momentum of mass M is

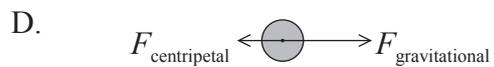
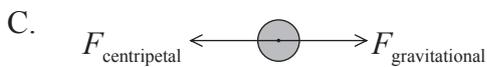
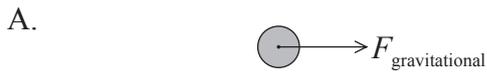
- A. mv .
 - B. $-mv$.
 - C. Mv .
 - D. $-Mv$.
4. A constant force acts on a mass that is initially at rest. Which of the following graphs best shows how the kinetic energy E_k of the mass changes with the work W done on the mass? Friction is negligible.



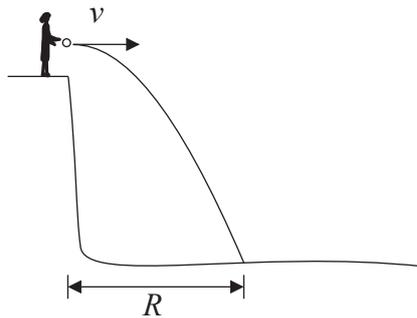
5. The Moon orbits the Earth.



Which of the following diagrams correctly represents the force(s) acting on the Moon?



6. A stone is thrown horizontally from the top of a cliff with an initial speed v .

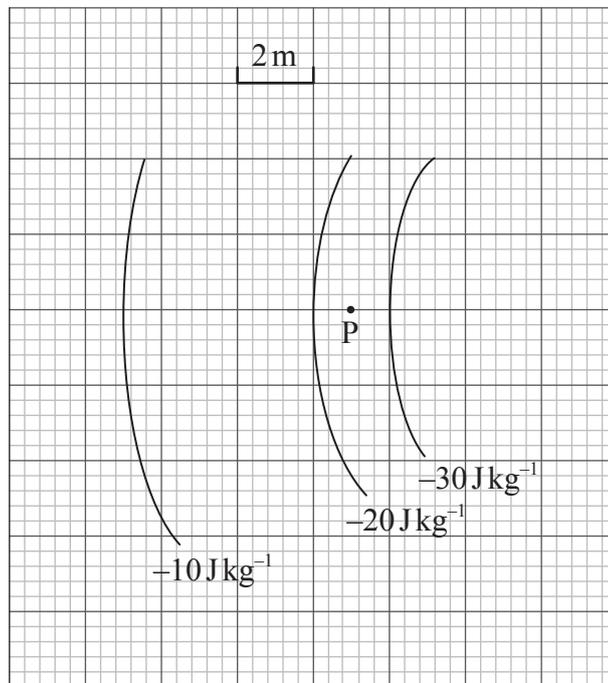


The time of flight of the stone is t and its range R . Air resistance is negligible.

For a stone that is thrown horizontally from the top of the cliff with an initial speed $3v$, which of the following is correct?

	Time of flight	Range
A.	t	R
B.	$3t$	$3R$
C.	t	$3R$
D.	$3t$	R

7. A charged particle is moved at constant speed between two points in an electric field. The work done between the two points is determined by the
- A. value of the charge and the path taken.
 - B. value of the charge.
 - C. path taken.
 - D. speed.
8. The diagram below represents equipotential lines of a gravitational field.

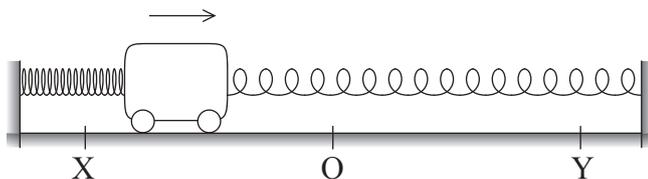


Which of the following is the direction and strength of the field at point P?

	Direction	Strength
A.	←	5.0 N kg^{-1}
B.	→	5.0 N kg^{-1}
C.	←	13 N kg^{-1}
D.	→	13 N kg^{-1}

9. The temperature of an ideal gas is a measure of the molecules' average
- A. velocity.
 - B. momentum.
 - C. kinetic energy.
 - D. frequency of collisions.
10. For an ideal gas of constant mass the pressure is always proportional to
- A. density and volume.
 - B. density and temperature.
 - C. volume and temperature.
 - D. volume only.
11. Which of the following statements is in agreement with the second law of thermodynamics?
- A. It is possible to continuously convert thermal energy fully into work.
 - B. In natural processes, local entropy must increase.
 - C. Thermal energy will not flow by itself from cold to hot bodies.
 - D. The entropy in a closed system tends to decrease.

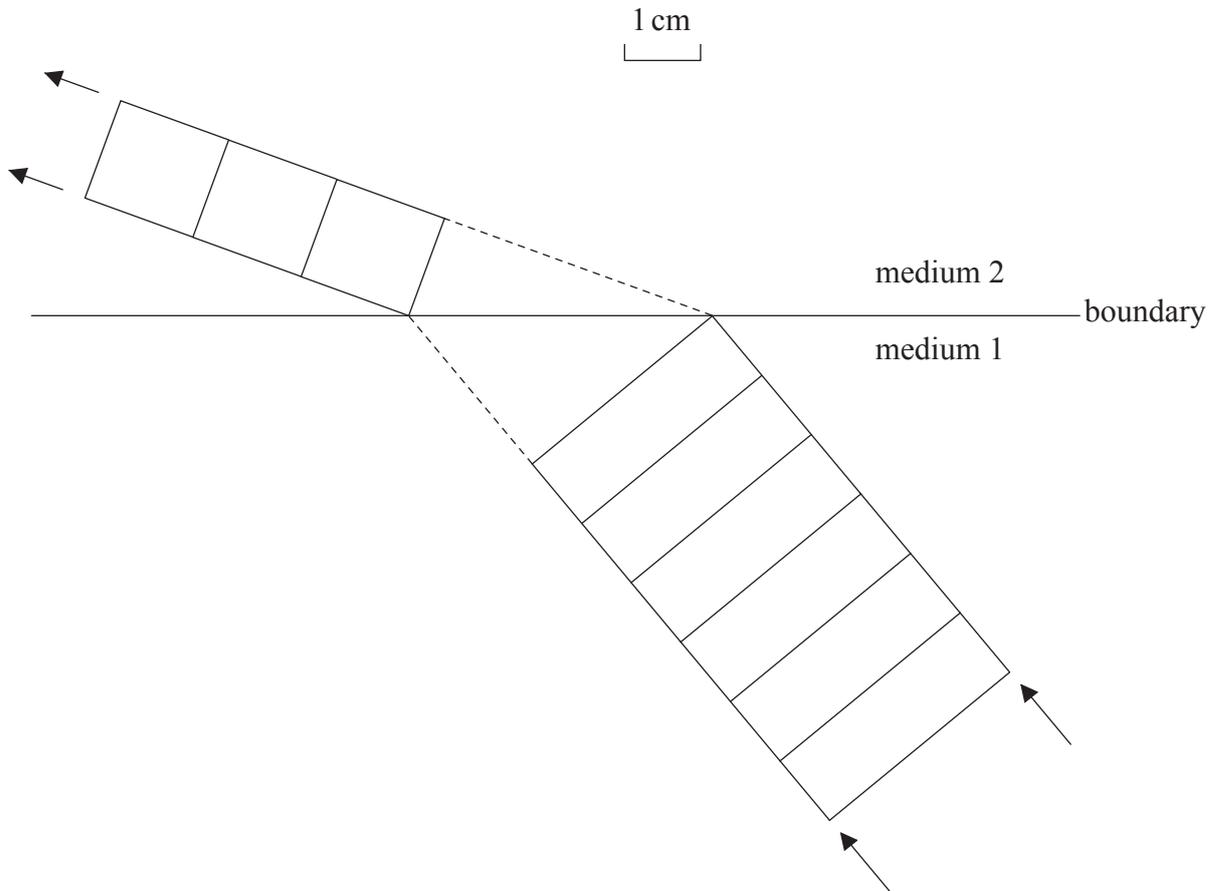
12. A cart, connected to two identical springs, is oscillating with simple harmonic motion between two points X and Y that are equidistant from point O.



The cart is in equilibrium at

- A. all points between X and Y.
 - B. point O only.
 - C. points X and Y only.
 - D. points O, X and Y only.
13. For a system executing simple harmonic motion, the restoring force acting on the system is proportional to the
- A. displacement of the system from equilibrium.
 - B. amplitude of oscillation.
 - C. elastic potential energy.
 - D. frequency of oscillation.

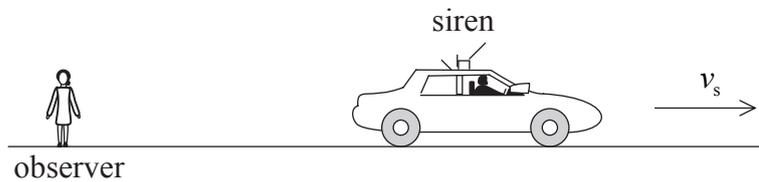
14. Plane wavefronts are incident on a boundary between two media labelled 1 and 2 in the diagram. The diagram of the wavefronts is drawn to scale.



The ratio of the refractive index of medium 2 to that of medium 1 is

- A. 0.50.
- B. 0.67.
- C. 1.5.
- D. 2.0.

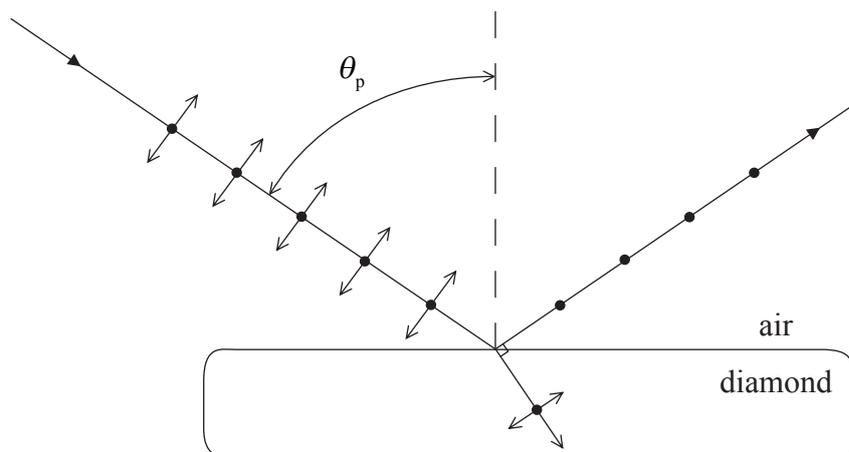
15. Which of the following statements is true for a standing wave on a string?
- A. No energy is transferred along the string.
 - B. The maximum kinetic energy of each segment of the string is proportional to the amplitude of the segment.
 - C. Each segment of the string oscillates with different phase and frequency.
 - D. The amplitude along the string varies with time.
16. A siren at rest emits a sound of frequency f_0 . The speed of sound in air is v . The siren moves away from an observer at rest relative to the siren in a straight line with constant speed v_s .



The observer measures a frequency lower than f_0 because the

- A. speed at which the sound moves relative to the observer is $v - v_s$.
 - B. speed at which the sound moves relative to the observer is $v_s - v$.
 - C. wavelength measured by the observer is smaller by a factor $\frac{v_s}{v}$.
 - D. wavelength measured by the observer is greater by a factor $\frac{v_s}{v}$.
17. In an electron microscope, high energy electrons are used in order to increase the
- A. interference effects.
 - B. diffraction effects.
 - C. resolving power of the microscope.
 - D. magnifying power of the microscope.

18. The diagram represents a beam of unpolarized light incident on a diamond.



The refractive index of the diamond is n .

At an angle θ_p , the beam reflected from the diamond is plane polarized normal to the page. The angle θ_p is

- A. $\tan^{-1} n$.
- B. $\tan^{-1} \left(\frac{1}{n} \right)$.
- C. $\sin^{-1} \left(\frac{1}{n} \right)$.
- D. $\cos^{-1} \left(\frac{1}{n} \right)$.

19. Two polarizing sheets have planes of polarization that are initially parallel.



The incoming light on sheet 1 is unpolarized. The intensity of the light transmitted is I . To reduce the intensity to $\frac{I}{2}$, which sheet must be rotated and through what angle?

	Sheet to be rotated	Rotation angle
A.	1 only	$\theta = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$
B.	2 only	$\theta = \cos^{-1}\left(\frac{1}{2}\right)$
C.	1 or 2	$\theta = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$
D.	1 or 2	$\theta = \cos^{-1}\left(\frac{1}{2}\right)$

20. The electronvolt is a unit of

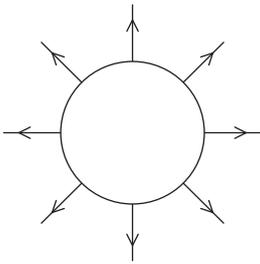
- A. force.
- B. potential difference.
- C. energy.
- D. electric field strength.

21. Which of the following correctly gives the resistance of an ideal ammeter and resistance of an ideal voltmeter?

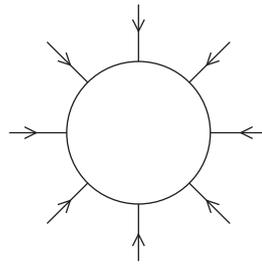
	Ammeter	Voltmeter
A.	infinite	infinite
B.	zero	zero
C.	zero	infinite
D.	infinite	zero

22. A hollow metallic sphere is negatively charged. Which of the following correctly represents the electric field?

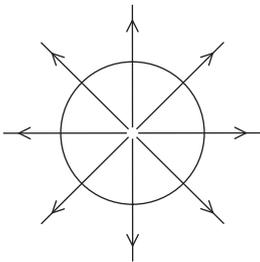
A.



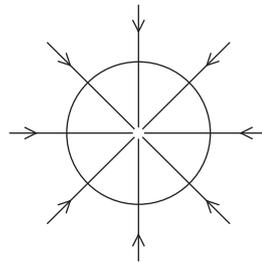
B.



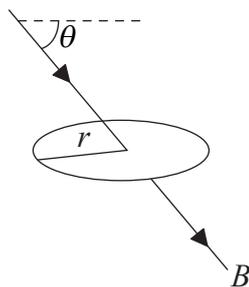
C.



D.



23. A disc of radius r is placed in a uniform magnetic field. The magnitude of the field strength is B and it makes an angle θ to the plane of the disc.

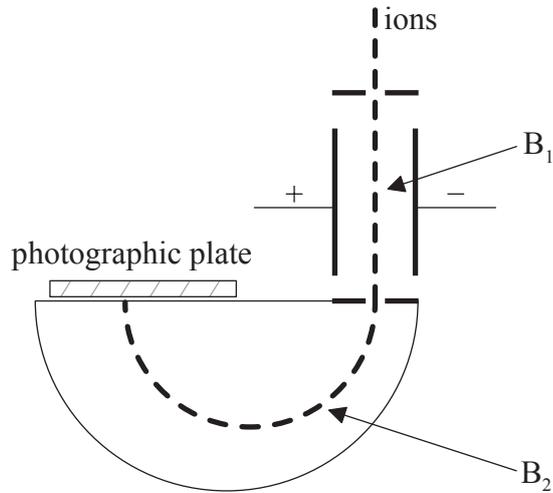


The magnetic flux linking the disc is

- A. $\pi r^2 B$.
- B. $\pi r^2 B \sin \theta$.
- C. $\pi r^2 B \cos \theta$.
- D. $\pi r^2 B \tan \theta$.
24. A magnetic flux linking a wire loop changes sinusoidally with time. The emf induced in the loop changes sinusoidally
- A. in phase with the changing flux.
- B. out of phase with the changing flux by a quarter period.
- C. out of phase with the changing flux by a third of a period.
- D. out of phase with the changing flux by half a period.
25. The maximum output voltage of a generator is V_0 . The frequency of rotation of the generator coil is doubled. What is the new maximum output voltage?
- A. V_0
- B. $\sqrt{2} V_0$
- C. $2 V_0$
- D. $4 V_0$

26. A photon has
- A. energy and momentum.
 - B. no energy.
 - C. energy only.
 - D. no momentum.
27. The de Broglie hypothesis applies to
- A. nucleons only.
 - B. electrons only.
 - C. photons only.
 - D. all particles.
28. In the Schrödinger model of the hydrogen atom a wavefunction of amplitude A is assigned to the electron. The probability of locating the electron at a region of space within the atom is proportional to
- A. A^{-1} .
 - B. \sqrt{A} .
 - C. A .
 - D. A^2 .
29. Which of the following lists the particles associated with radioactive decay in order of **increasing** ionizing power?
- A. α, β, γ
 - B. γ, α, β
 - C. β, α, γ
 - D. γ, β, α

30. The diagram is a schematic representation of the Bainbridge mass spectrometer. Positive ions are injected between the plates of the speed selector.



Which of the following correctly shows the direction of the magnetic fields B_1 and B_2 ?

	B_1	B_2
A.	out of the page	out of the page
B.	into the page	into the page
C.	out of the page	into the page
D.	into the page	out of the page

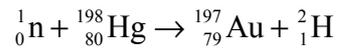
31. The design of a thermal fission reactor includes the following.

- I. Fuel rods
- II. Control rods
- III. Moderator

Which part(s) help maintain a constant rate of fission in the core of a reactor?

- A. I, II and III
- B. I and II only
- C. II only
- D. III only

32. A nuclear reaction is represented by the following equation.



This reaction is an example of

- A. fission.
 - B. fusion.
 - C. natural transmutation.
 - D. artificial (induced) transmutation.
33. The binding energy of a nucleus is defined to be the
- A. energy released when a nucleus is formed from its individual constituents.
 - B. energy released when the nucleus is separated into its individual constituents.
 - C. total energy of the nucleus.
 - D. total energy of the protons inside the nucleus.
34. The power per unit length P of an oscillating water column (OWC) is due to the action of a surface wave of amplitude A . Which of the following correctly relates P and A , and correctly identifies the nature of the energy of the water column?

	Relation between P and A	Nature of energy
A.	$P \propto A$	kinetic
B.	$P \propto A$	kinetic and potential
C.	$P \propto A^2$	kinetic
D.	$P \propto A^2$	kinetic and potential

35. The average temperature of the surface of the Sun is about 20 times more than the average surface temperature of the Earth. The average power per unit area radiated by the Earth is P . The average power per unit area radiated by the Sun is
- A. $20P$.
 - B. $400P$.
 - C. $8000P$.
 - D. $160\,000P$.
36. Most climate scientists agree that the enhanced greenhouse effect is due to
- A. cyclical changes of the Earth's orbit.
 - B. volcanic activity.
 - C. the burning of fossil fuels.
 - D. increased solar activity.
37. Global warming reduces the ice and snow cover on Earth. Which of the following correctly describes the changes in albedo and rate of energy absorption by Earth?

	Albedo	Rate of energy absorption
A.	increase	increase
B.	decrease	increase
C.	increase	decrease
D.	decrease	decrease

38. A compact disc player uses laser light to read a disc. The height of one pit on the CD is about $\frac{1}{4}$ of the wavelength of the laser light. The light illuminates the edge of a pit. Which of the following is correct with reference to the interference of the light and the binary information registered?

	Interference	Binary information
A.	constructive	0
B.	destructive	1
C.	constructive	1
D.	destructive	0

39. Light incident on a pixel element in a charge-coupled device (CCD) produces electron-hole pairs. This is due to
- A. the photoelectric effect.
 - B. a temperature gradient in the semiconductor lattice.
 - C. electrodes across the surface of the pixel element.
 - D. a chemical reaction on the oxide insulator.
40. A CCD camera is used to take the picture of an object of length 30 m. The image of the object on the chip measures 0.03 mm. The magnification is
- A. 10^6 .
 - B. 10^3 .
 - C. 10^{-3} .
 - D. 10^{-6} .
-