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**PHYSICS
HIGHER LEVEL
PAPER 1**

Monday 6 May 2013 (morning)

1 hour

INSTRUCTIONS TO CANDIDATES

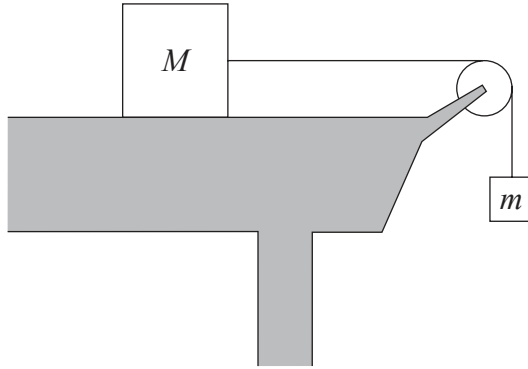
- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **Physics Data Booklet** is required for this paper.
- The maximum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

1. Which of the following lists three vector quantities?
 - A. momentum, electric field strength, displacement
 - B. momentum, displacement, pressure
 - C. pressure, electric current, displacement
 - D. electric current, electric field strength, impulse

2. Which of the following is necessary for an object to be in translational equilibrium?
 - A. The object must be stationary.
 - B. The object must move with a constant speed.
 - C. The resultant force acting on the object must be zero.
 - D. No forces must act on the object.

3. An object, initially at rest, travels a distance d in a time t at a constant acceleration. What is the time taken for the object to travel $16d$ from rest at the same acceleration?
 - A. $16t$
 - B. $8t$
 - C. $4t$
 - D. $2t$

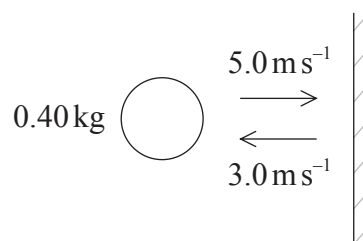
4. An object of mass m is connected via a frictionless pulley to an object of mass M , where $M > m$. M rests on a horizontal frictionless surface.



What is the acceleration of the system?

- A. $\frac{mg}{(M + m)}$
- B. $\frac{(M + m)g}{m}$
- C. $\frac{gm}{M}$
- D. Zero

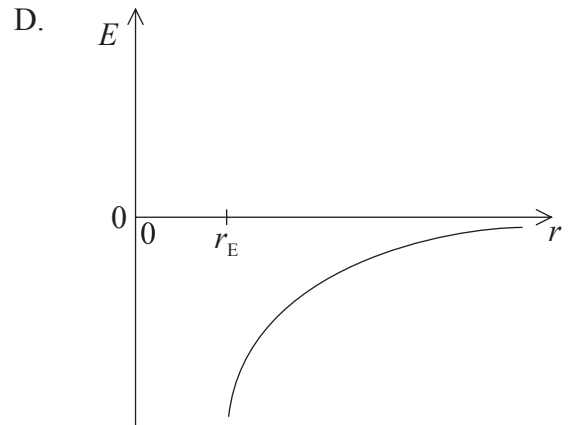
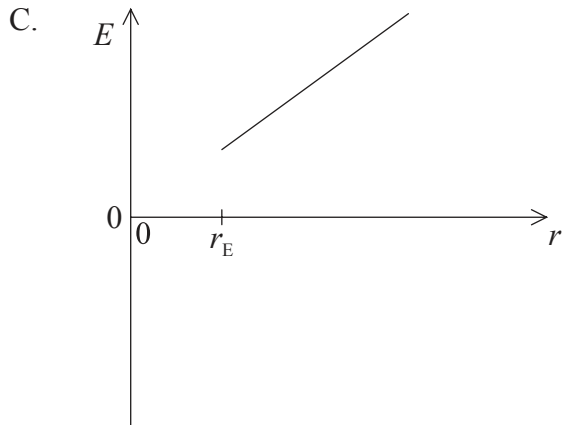
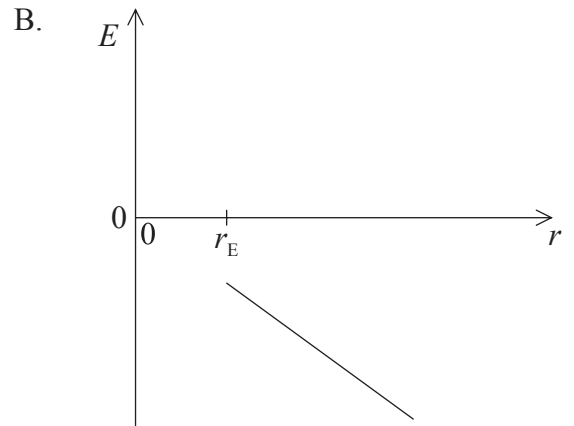
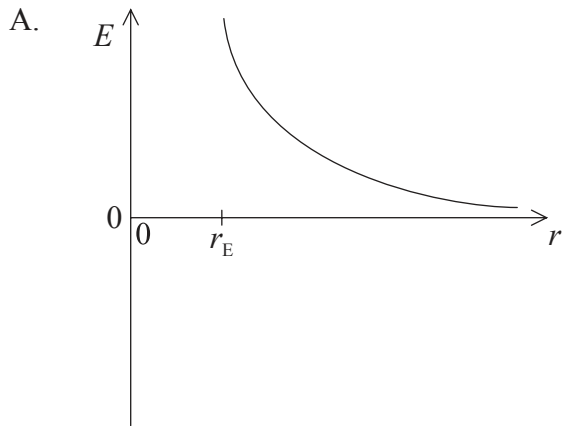
5. A ball of mass 0.40 kg travels horizontally and strikes a vertical wall with a speed of 5.0 m s^{-1} . It rebounds horizontally with a speed of 3.0 m s^{-1} . The ball is in contact with the wall for a time of 0.20 s .



What is the average magnitude of the force exerted by the ball on the wall?

- A. 0.16 N
- B. 0.64 N
- C. 4 N
- D. 16 N

6. Which graph shows how the total energy E of an orbiting satellite varies with distance r from the centre of the Earth, where r_E is the radius of the Earth?



7. An object is thrown horizontally from the edge of a high crater on the Moon. The Moon has no atmosphere. Which of the following describes the changes, if any, to the horizontal and vertical components of the velocity of the object?

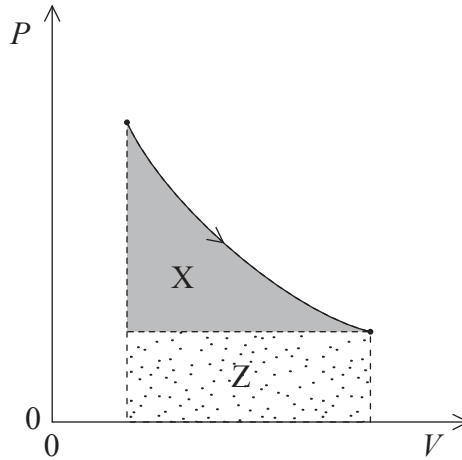
	Horizontal velocity	Vertical velocity
A.	stays constant	increases at a constant rate
B.	decreases	increases at a constant rate
C.	stays constant	increases at a non-constant rate
D.	decreases	increases at a non-constant rate

8. The temperature of an object is -153°C . Its temperature is raised to 273°C . What is the temperature change of the object?
- A. 699 K
- B. 426 K
- C. 153 K
- D. 120 K
9. Two ideal gases X and Y are at the same temperature. The mass of the molecules of gas X is twice the mass of the molecules of gas Y.

What is the ratio $\frac{\text{average speed of molecules of gas X}}{\text{average speed of molecules of gas Y}}$?

- A. $\frac{1}{2}$
- B. $\frac{1}{\sqrt{2}}$
- C. $\sqrt{2}$
- D. 2

10. The graph shows the variation of pressure P with volume V for a gas undergoing an adiabatic expansion.

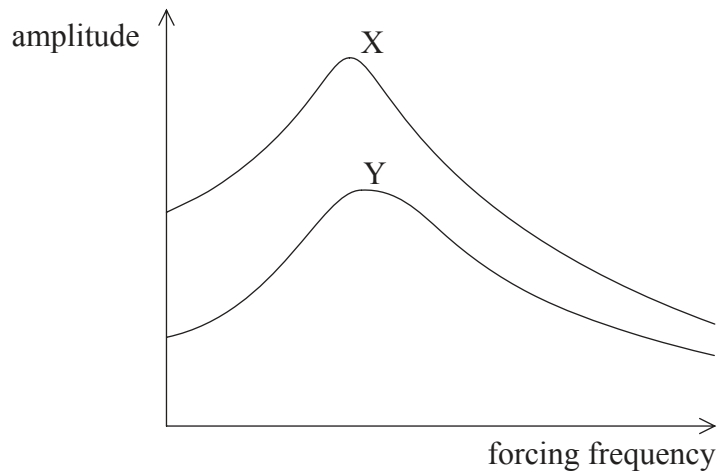


Which of the following areas correctly identifies the work done by the gas?

- A. X
 - B. X+Z
 - C. X-Z
 - D. Z
11. An isolated system consists of a block of ice floating in a glass of water. The ice melts completely at constant temperature. Which of the following identifies the change in internal energy of the system and the change in entropy of the system?

	Internal energy	Entropy
A.	no change	increase
B.	no change	decrease
C.	increase	decrease
D.	increase	increase

12. Two oscillators X and Y are undergoing forced oscillations each at a frequency close to the natural frequency of each oscillator. The graph shows the variation of amplitude with forcing frequency for each oscillator.



Which of the following correctly identifies the system that has the greater amount of damping and the greater natural frequency of oscillation?

	Greater amount of damping	Greater natural frequency
A.	X	X
B.	X	Y
C.	Y	X
D.	Y	Y

13. An object undergoes simple harmonic motion with time period T and amplitude 0.5 m. At time $t=0$ s the displacement of the object is a maximum.

What is the displacement of the object at time $t = \frac{3T}{4}$?

- A. -0.50 m
- B. 0.50 m
- C. 0.25 m
- D. 0 m

14. Light of wavelength 600 nm travels from air to glass at normal incidence. The refractive index of the glass is 1.5. The speed of light in air is c . Which of the following correctly identifies the speed of the waves and their wavelength in the glass?

	Speed	Wavelength
A.	$\frac{2c}{3}$	900 nm
B.	c	900 nm
C.	c	400 nm
D.	$\frac{2c}{3}$	400 nm

15. A stationary source of sound emits sound of frequency f . A moving observer measures the sound as having the frequency f' . The observer is moving directly away from the source at a speed that is 30% of the speed of sound in air.

Which of the following gives the correct value for $\frac{f'}{f}$?

- A. $\frac{7}{10}$
- B. $\frac{10}{13}$
- C. $\frac{13}{10}$
- D. $\frac{10}{7}$

16. The air in a pipe, of length l and open at both ends, vibrates with a fundamental frequency f . What is the fundamental frequency of a pipe of length $1.5l$ and closed at one end?

A. $\frac{f}{3}$

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

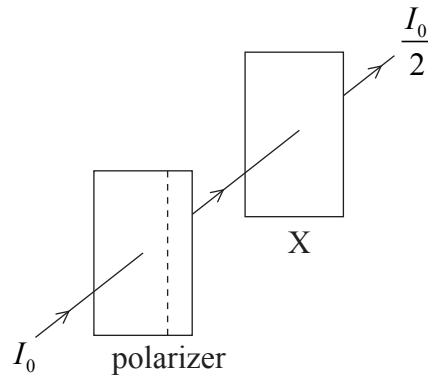
C. $\frac{3f}{2}$

D. $3f$

17. An optical instrument is used to observe an object illuminated with monochromatic light. Which of the following changes to the frequency of the light and to the aperture diameter of the optical instrument will increase the resolution of the image of the object formed by the instrument?

	Frequency	Aperture diameter
A.	increase	decrease
B.	decrease	decrease
C.	increase	increase
D.	decrease	increase

18. Unpolarized light of intensity I_0 is incident on a polarizer with a vertical transmission axis. The transmitted light is incident on a sheet of material X. After transmission through X the intensity of the light is $\frac{I_0}{2}$.



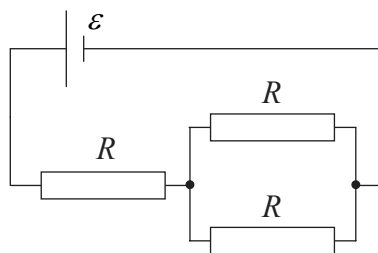
It is suggested that X could be

- I. a polarizer with vertical transmission axis
- II. a polarizer with horizontal transmission axis
- III. non polarizing glass.

Which of the above suggestions is/are correct?

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

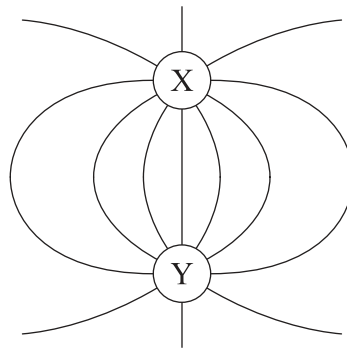
19. An electric circuit consists of three identical resistors of resistance R connected to a cell of emf ε and negligible internal resistance.



What is the magnitude of the current in the cell?

- A. $\frac{\varepsilon}{3R}$
- B. $\frac{2\varepsilon}{3R}$
- C. $\frac{3\varepsilon}{2R}$
- D. $\frac{3\varepsilon}{R}$
20. A copper wire with length L and radius r has a resistance R .
- What is the radius of a copper wire with length $\frac{L}{2}$ and resistance R ?
- A. $2r$
- B. $\sqrt{2}r$
- C. $\frac{r}{\sqrt{2}}$
- D. $\frac{r}{2}$

21. The diagram shows the electric field pattern due to two point charges X and Y. Y is a negative charge.



Which of the following correctly identifies the charge X and the direction of the electric field?

	Sign of charge X	Direction of electric field
A.	positive	Y to X
B.	positive	X to Y
C.	negative	X to Y
D.	negative	Y to X

22. The magnitude of the gravitational field strength at the surface of a planet of mass M and radius R is g . What is the magnitude of the gravitational field strength at the surface of a planet of mass $2M$ and radius $2R$?

- A. $\frac{g}{4}$
- B. $\frac{g}{2}$
- C. g
- D. $2g$

23. An ideal transformer has a primary coil with N_p turns and a secondary coil with N_s turns. The electrical power input to the primary is P . Which of the following is the power output from the secondary?

A. $\left(\frac{N_p}{N_s}\right)P$

B. P

C. $\left(\frac{N_s}{N_p}\right)P$

D. $\frac{1}{P}$

24. An alternating current generator produces a root mean squared (rms) emf of ε at a frequency f . The rotational speed of the coil in the generator is doubled. Which of the following correctly identifies the new output rms emf and the new frequency?

	emf	Frequency
A.	2ε	$2f$
B.	$\sqrt{2}\varepsilon$	$2f$
C.	2ε	$\frac{f}{2}$
D.	$\sqrt{2}\varepsilon$	$\frac{f}{2}$

25. The electric potential is V_R at a point R in an electric field and at another point S the electric potential is V_S . Which of the following is the work done by the electric field on a point charge $+q$ as it moves from R to S?

A. $V_R - V_S$

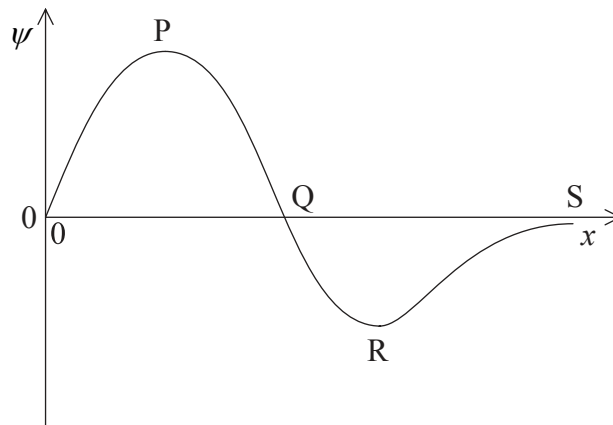
B. $q(V_R - V_S)$

C. $V_S - V_R$

D. $q(V_S - V_R)$

26. Which particle is acted on by both the strong nuclear force and the Coulomb force?
- A. Antineutrino
 - B. Electron
 - C. Neutron
 - D. Proton
27. Which of the following gives the particles of the same energy in an increasing order of ionizing ability?
- A. β , α , γ
 - B. α , β , γ
 - C. γ , α , β
 - D. γ , β , α
28. The decay constant of a radioactive isotope with half-life T is defined as
- A. $\frac{T}{\ln 2}$.
 - B. the rate of decay of one nucleus of the isotope per second.
 - C. $T \ln 2$.
 - D. the probability of decay of one nucleus of the isotope per unit of time.
29. Which of the following provides evidence for the existence of isotopes?
- A. Measurements of nuclear masses
 - B. Alpha particle scattering
 - C. Radioactive decay
 - D. Atomic line spectra

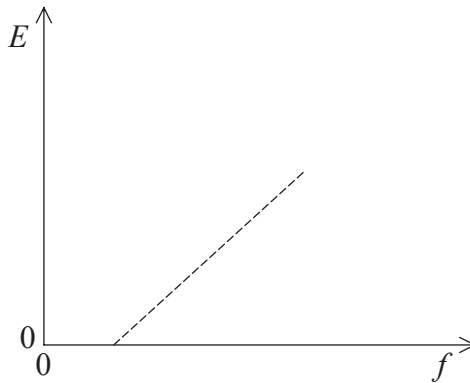
30. The diagram shows how the wavefunction ψ of an electron varies with distance x from a fixed origin.



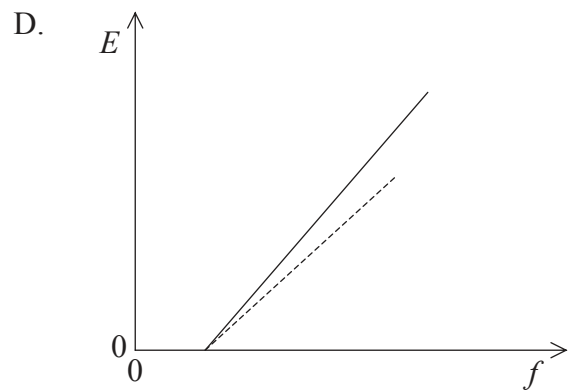
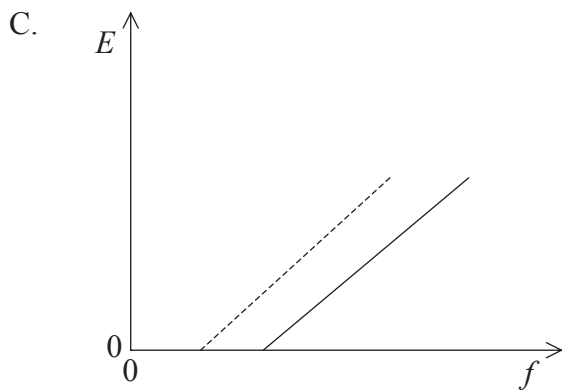
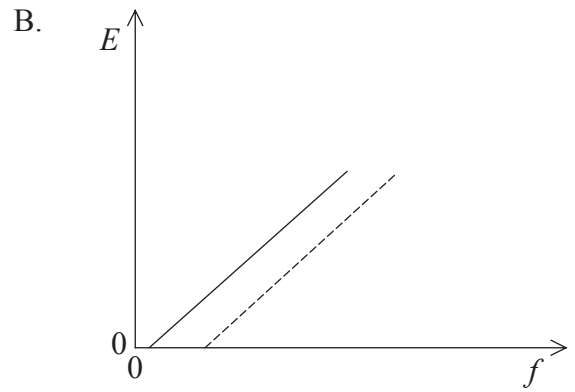
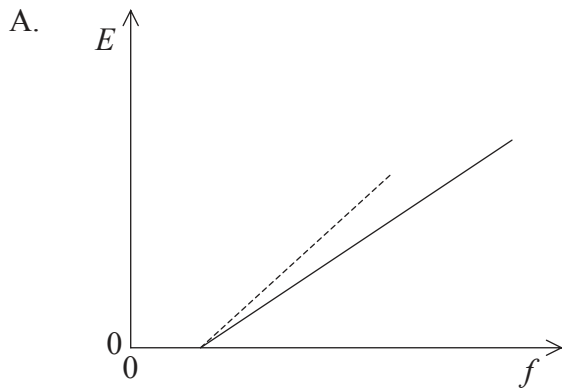
Which of the following indicates where the electron is most likely to be found?

- A. P
- B. Q
- C. R
- D. S

31. Light is incident on a clean metal surface and photoelectrons are emitted. The graph shows how the maximum kinetic energy E of the photoelectrons varies with frequency f of the incident light.



Which graph correctly identifies the variation of the maximum kinetic energy E of the photoelectrons for a metal surface with a higher threshold frequency? (The original graph is shown dotted.)



32. A pure sample of an unknown radioactive nuclide has a very long half-life. For the sample the following quantities are known
- I. the number of nuclei in the sample
 - II. the mass of the sample
 - III. the activity of the sample.

Which of the following will enable the half-life of the nuclide to be determined?

- A. III only
 - B. II and III only
 - C. I and III only
 - D. II only
33. A nucleus of plutonium-239 can be produced from a nucleus of uranium-238 by a process which is initiated by
- A. beta capture.
 - B. alpha capture.
 - C. neutron capture.
 - D. neutrino capture.
34. The surface heat capacity of the surface of a planet is defined to be the energy required to raise the temperature by 1 degree of
- A. unit mass of the surface.
 - B. unit area of the surface.
 - C. the total area of the land.
 - D. the total area of the land and the oceans.

35. Which of the following correctly describes the energy transformation within photovoltaic cells and within solar heating panels?

	Photovoltaic cells	Solar heating panels
A.	solar to thermal	solar to electrical
B.	solar to thermal	solar to thermal
C.	solar to electrical	solar to electrical
D.	solar to electrical	solar to thermal

36. An oscillating water column (OWC) ocean-wave converter produces a power P . What is the power output of this converter if the amplitude and speed of the waves are both doubled?

- A. $2P$
- B. $4P$
- C. $8P$
- D. $16P$

37. A student states that the following factors may lead to global warming

- I. decreased albedo of the Earth's surface
- II. increase in volcanic activity
- III. deforestation.

Which of the above statements are correct?

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

38. For the five-bit binary number 10110, which of the following correctly identifies the least-significant bit and the equivalent decimal number?

	Least-significant bit	Equivalent decimal number
A.	0	13
B.	1	13
C.	0	22
D.	1	22

39. A DVD player uses laser light with a frequency of 5×10^{14} Hz. The speed of the laser light in the transparent protective coating of the disc is 2×10^8 m s⁻¹. What is the depth of the pit used in the DVD?
- A. 100 nm
- B. 150 nm
- C. 200 nm
- D. 300 nm
40. A charge-coupled device (CCD) forms the image of a distant object. The distance between the image and object is now changed so that the length of the image on the CCD is halved. As a result of this change, the magnification is
- A. unchanged.
- B. squared.
- C. doubled.
- D. halved.