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PHYSICS
HIGHER LEVEL
PAPER 1

Monday 16 November 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 time elapsed since the beginning of the universe is of the order of

   A. 10^8 s.

   B. 10^{18} s.
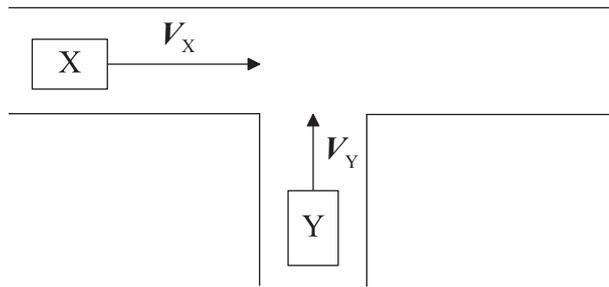
   C. 10^{28} s.

   D. 10^{38} s.

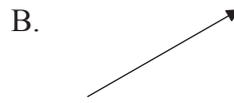**2.** The graph shows how the velocity of a particle varies with time.
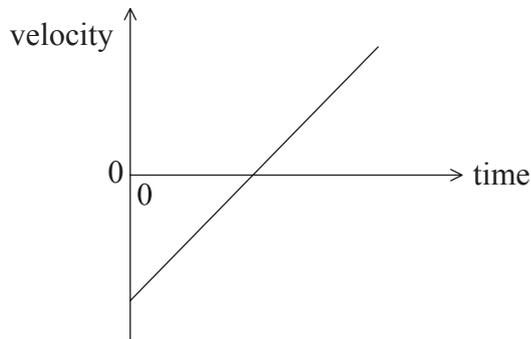
Which of the following graphs correctly shows how the acceleration of the particle varies with time?

A.

B.

C.

D.
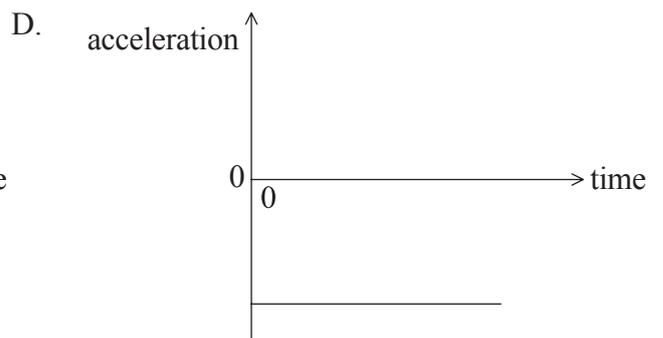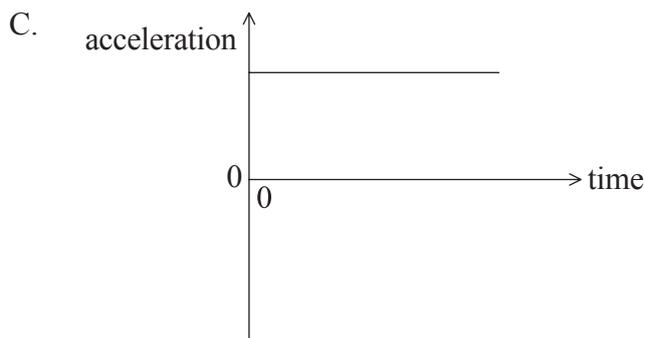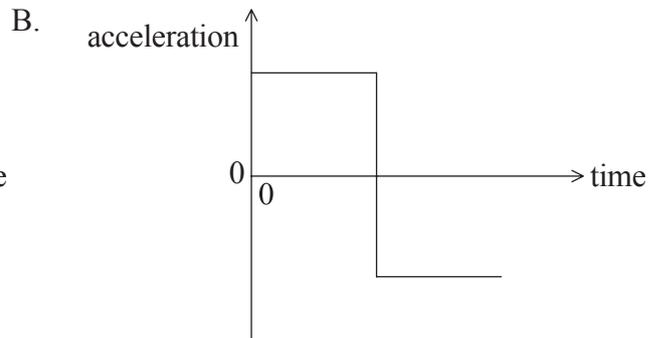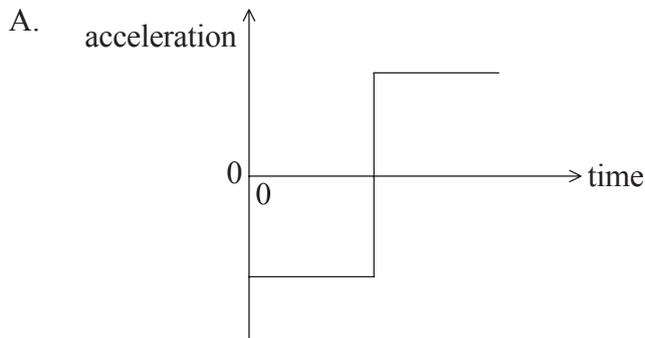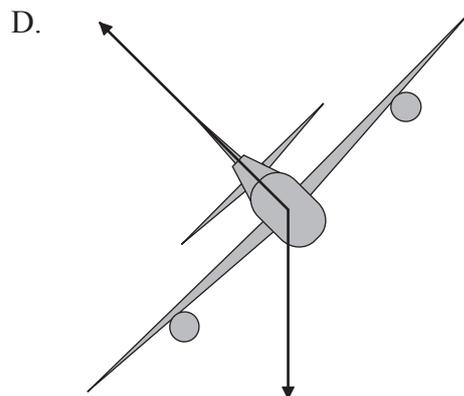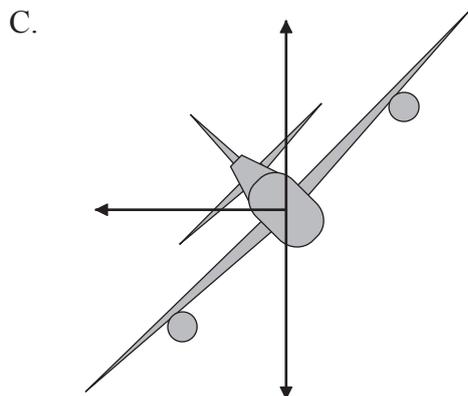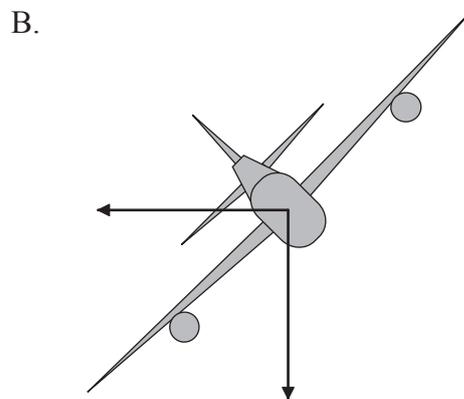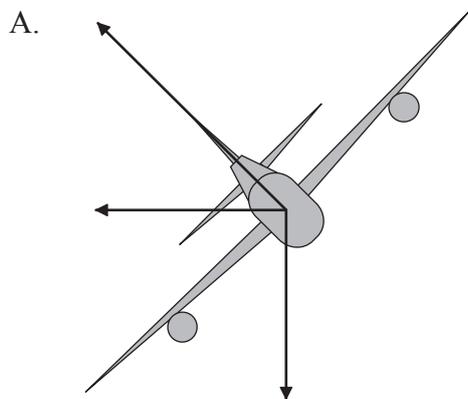
3. Two cars, X and Y, are travelling towards a junction. The velocity of car X is V_X and car Y is V_Y.

Which of the following vectors represent the velocity of Y relative to X?

A.

B.

C.

D.

4. An aircraft is flying at constant speed in a horizontal circle. Which of the following diagrams best illustrates the forces acting on the aircraft in the vertical plane?

A.

B.

C.

D.

5. If a moving object is subject to a constant force, which of the following can be correctly deduced from Newton's first law?

A. The object continues to move with a changing velocity.

B. The object continues to move with a constant velocity.

C. The object continues to move with a changing direction.

D. The object continues to move in the same direction.

6. A vehicle is driven up a hill at constant speed. Which of the following best describes the energy changes involved?

A. Chemical energy is converted into gravitational potential energy.

B. Chemical energy is converted into gravitational potential energy, sound and thermal energy.

C. Gravitational potential energy is converted into chemical energy.

D. Gravitational potential energy is converted into chemical energy, sound and thermal energy.

7. Which of the following represents a scalar and a vector quantity?

|	**Scalar**	**Vector**
A.	electric potential	electric potential gradient
B.	electric potential gradient	electric potential
C.	electric potential	electric potential difference
D.	electric potential gradient	electric field

8. A football is kicked with an initial velocity u at an angle θ to the horizontal and reaches the ground t seconds later.
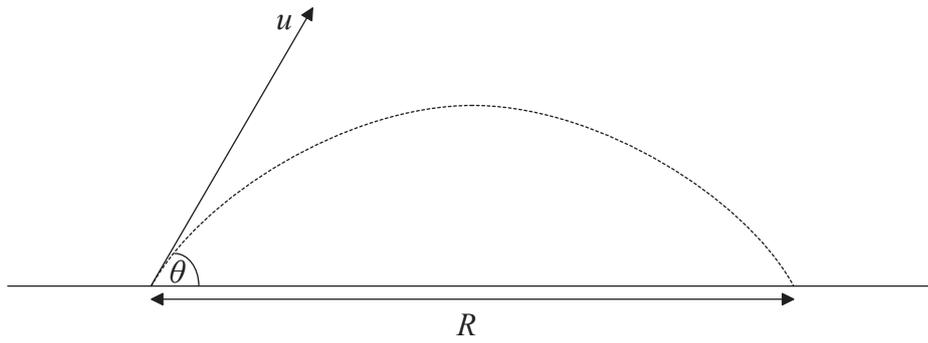
Ignoring air resistance what is the range R of the football?

A. ut

B. $ut\cos\theta$

C. $ut\sin\theta$

D. $ut\tan\theta$

Turn over

9. Four point charges of magnitudes $+q$, $+q$, $-q$, and $-q$ are held in place at the corners of a square of side r.
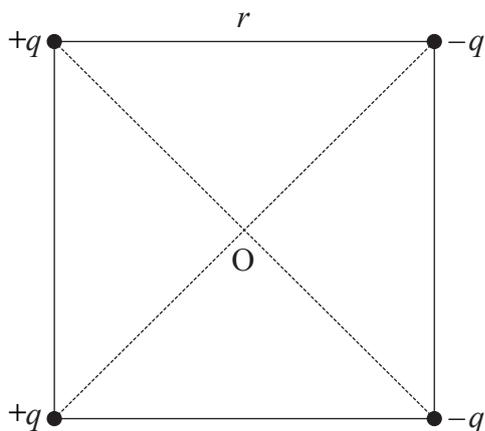
The Coulomb constant is k. Which of the following is the electrical potential at the centre of the square O?

A.   0

B. $\dfrac{4kq}{r}$

C. $\dfrac{4kq\sqrt{2}}{r}$

D. $\dfrac{-4kq\sqrt{2}}{r^2}$

10. Carbon has a relative atomic mass of 12 and oxygen has a relative atomic mass of 16. A sample of 6 g of carbon has twice as many atoms as

A.   32 g of oxygen.

B.   8 g of oxygen.

C.   4 g of oxygen.

D.   3 g of oxygen.

11. Tanya heats $100\,g$ of a liquid with an electric heater which has a constant power output of $60\,W$. After $100\,s$ the rise in temperature is $40\,K$. The specific heat capacity of the liquid in $J\,kg^{-1}\,K^{-1}$ is calculated from which of the following?

A. $\dfrac{60\times100}{0.1\times40}$

B. $\dfrac{60\times0.1}{40}$

C. $\dfrac{0.1\times40}{60}$

D. $\dfrac{60}{40}$

12. The behaviour of real gases is different from that predicted for ideal gases. Which of the following statements about real gases is **not** correct?

A. Gas molecules have potential energy.

B. Forces between gas molecules are always negligible.

C. Gas molecules have volume.

D. Real gases can liquefy.

13. The graph below shows the variation of the pressure p with volume V of an ideal gas during one cycle of an engine.
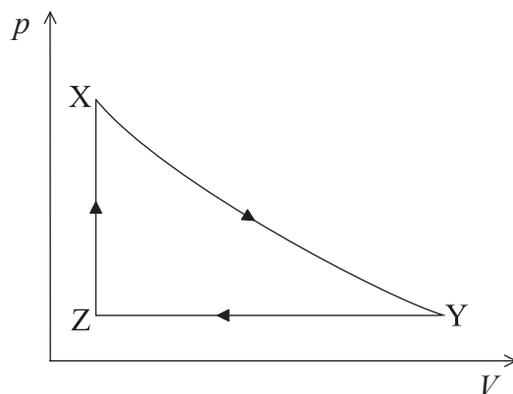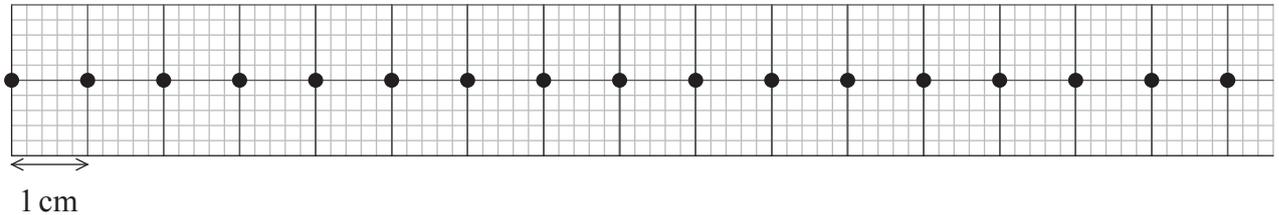

Which of the following correctly names the thermodynamic process associated with the parts Y→Z and Z→X of the cycle?

	Y→Z	Z→X
A.	isobaric	isochoric
B.	isobaric	isothermal
C.	isochoric	isobaric
D.	isochoric	isothermal

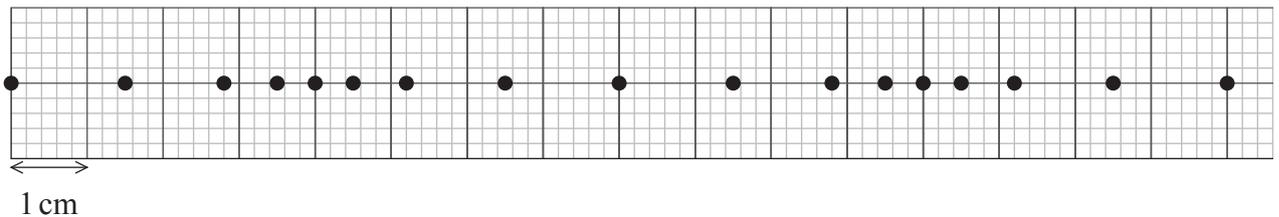*The following diagrams refer to questions 14 and 15.*

Diagram 1 represents equally spaced beads on a spring. The beads are 1 cm apart.

Diagram 1

1 cm

A longitudinal wave propagates along the spring. Diagram 2 shows the position of the beads at a particular instant.

Diagram 2

1 cm

14. Which of the following is the best estimate of the wavelength?
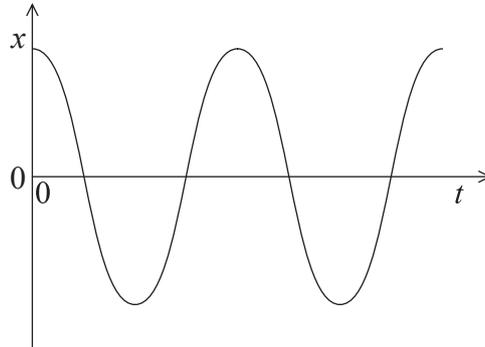
  A.   2 cm

  B.   4 cm

  C.   8 cm

  D.   16 cm

15. Which of the following is the best estimate of the amplitude?
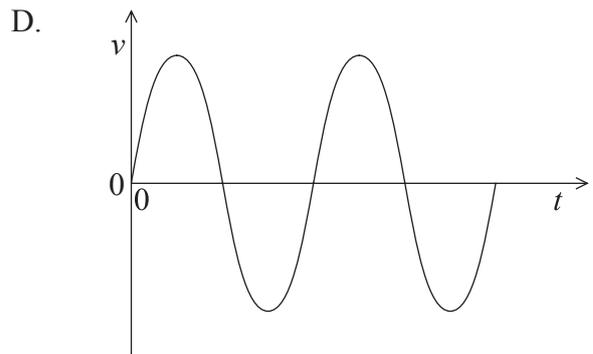
  A.   0.4 cm

  B.   0.8 cm

  C.   1.6 cm

  D.   3.2 cm

The following graph refers to questions 16 and 17.

The graph below shows how the displacement x of a particle undergoing simple harmonic motion varies with time t. The motion is undamped.

16. Which of the following graphs correctly shows how the velocity v of the particle varies with t?

A.

B.

C.

D.
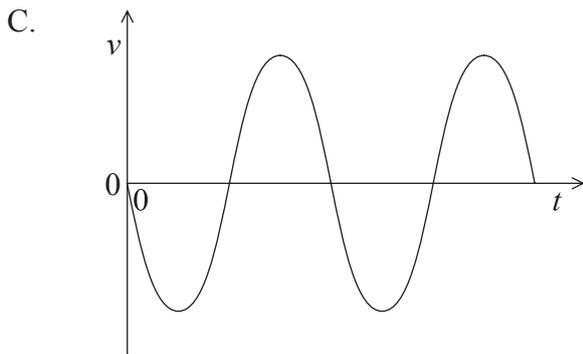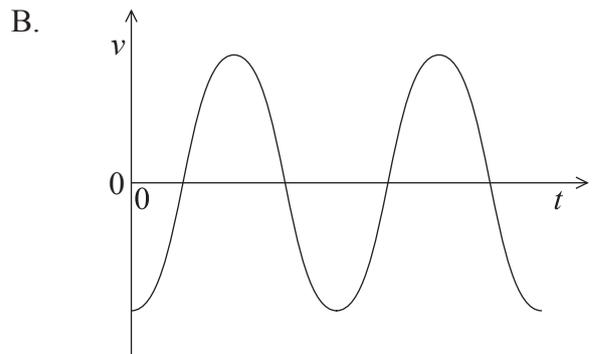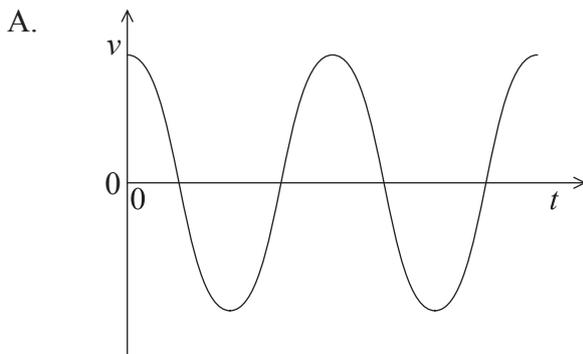
17. Which of the following graphs shows how the total energy E of the particle varies with time t?

A.

B.

C.

D.

18. Which of the following is a correct comparison between standing waves and travelling waves?

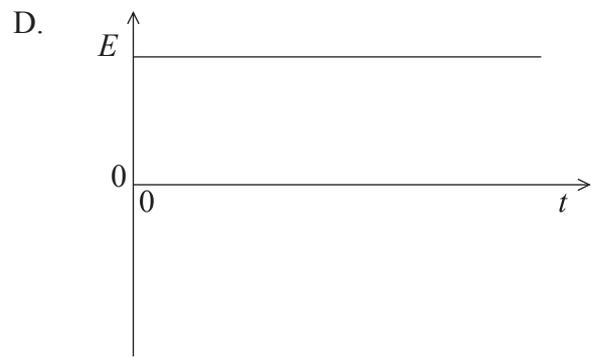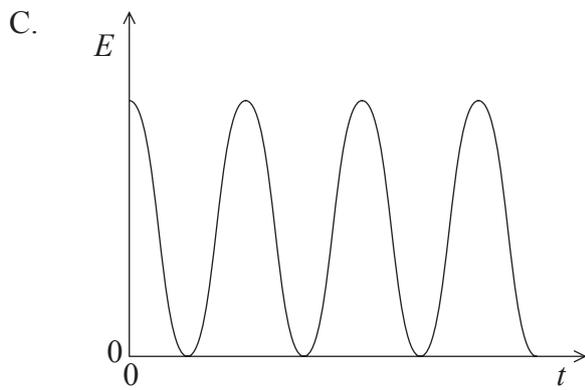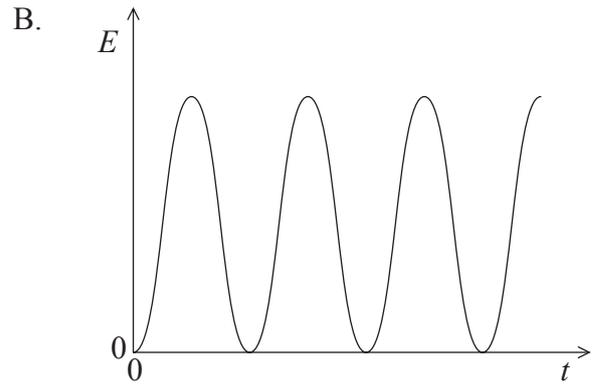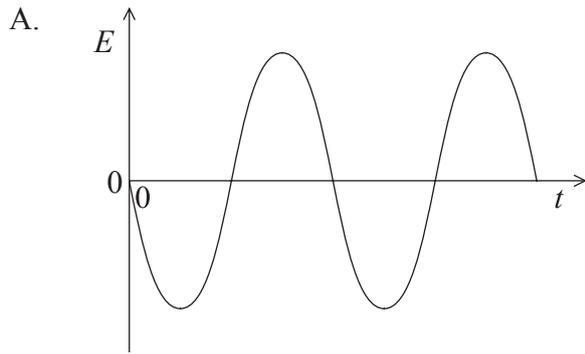|	**Standing waves**	**Travelling waves**
A.	wave amplitude is constant at all points along the wave	wave amplitude depends upon the position along the wave
B.	energy is always transferred	energy is not transferred
C.	the wavelength is twice the distance between consecutive nodes	the wavelength is the distance between consecutive crests
D.	phase varies continuously along the wave	phase is constant between consecutive crests

19. Two galaxies with an angular separation at the observer of 5.0×10^{-4} radians are observed with a radio telescope. Both galaxies emit radio waves of wavelength 2.5×10^{-2} m.

The images of the galaxies are just resolved by the telescope. The diameter of the circular collecting dish of the telescope is

    A.   61 m.

    B.   50 m.

    C.   30 m.

    D.   25 m.

20. The diagram shows sunlight reflected from a lake surface. The reflected sunlight is plane-polarized.
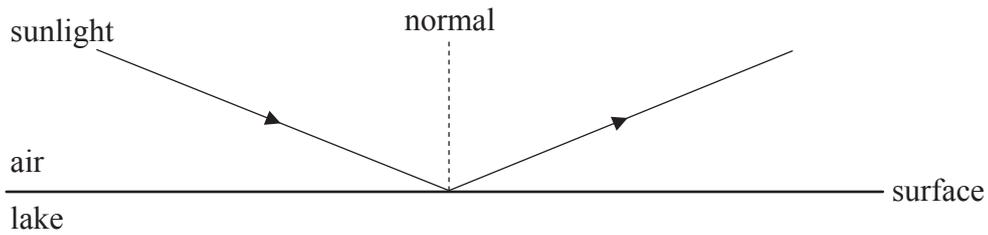
The plane of polarization of the reflected sunlight is

A.   parallel to the lake surface.

B.   perpendicular to the lake surface.

C.   parallel to the direction of the reflected sunlight.

D.   in the plane of the diagram.

21. The diagram below shows a particle with positive charge q accelerating between two conducting plates at potentials V_1 and V_2.
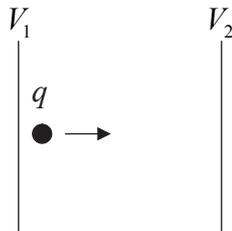
Which of the following is the kinetic energy gained by the charge in moving between the plates?

A. $V_2 q$

B. $V_1 q$

C. $(V_1 - V_2)q$

D. $(V_2 - V_1)q$

22. A cylindrical conductor of length l, diameter D and resistivity ρ has resistance R. A different cylindrical conductor of resistivity 2ρ, length $2l$ and diameter $2D$ has a resistance

A. $2R$.

B. R.

C. $\dfrac{R}{2}$.

D. $\dfrac{R}{4}$.

23. A small sphere X of mass M is placed a distance d from a point mass. The gravitational force on sphere X is $90\,\text{N}$. Sphere X is removed and a second sphere Y of mass $4M$ is placed a distance $3d$ from the same point mass. The gravitational force on sphere Y is

A. $480\,\text{N}$.

B. $160\,\text{N}$.

C. $120\,\text{N}$.

D. $40\,\text{N}$.

24. A test charge is a

A. charged object with a very small mass.

B. charged object with a very small charge.

C. point charge which has no effect on the electric field in which it is placed.

D. point charge which slightly changes the electric field in which it is placed.

25. A magnetic field of strength B links a coil. The direction of the field is normal to the plane of the coil. The graph shows how B varies with time t.
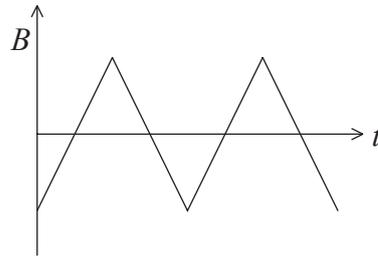
Which of the following graphs shows how the induced emf ε in the coil varies with t?

A.

B.

C.

D.
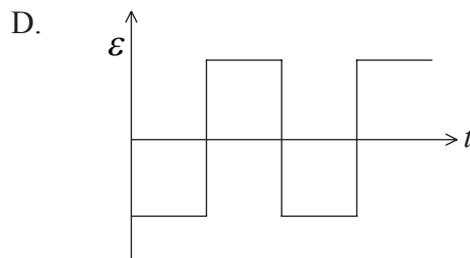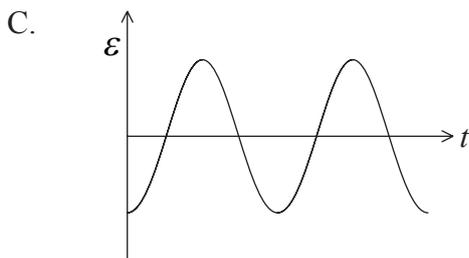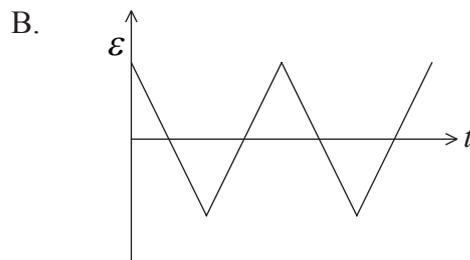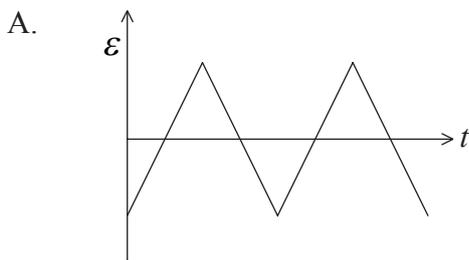
26. Raoul suggests that power losses in a transformer may be reduced by the following.

   I.   Constructing the core from a solid block of steel.

   II.   Using large diameter wire in the coils.

   III. Using wire of low resistivity.

Which of the above suggestions would reduce power loss?

A.   I only

B.   II only

C.   II and III only

D.   I, II and III

27. The relationship between proton number *Z*, neutron number *N* and nucleon number *A* is

A. $A=Z-N.$

B. $Z=A+N.$

C. $N=A-Z.$

D. $N=A+Z.$

28. In the Geiger–Marsden experiment α-particles are scattered by gold nuclei. The experimental results provide evidence that

A.   α-particles have discrete amounts of kinetic energy.

B.   most of the mass and positive charge of an atom is concentrated in a small volume.

C.   the nucleus contains protons and neutrons.

D.   gold atoms have a high binding energy per nucleon.

29. Protons and neutrons are held together in the nucleus by the

A.   electrostatic force.

B.   gravitational force.

C.   weak nuclear force.

D.   strong nuclear force.

30. A radioactive isotope has an initial activity A_0 and a half-life of 1 day. The graph shows how the activity A varies with time.
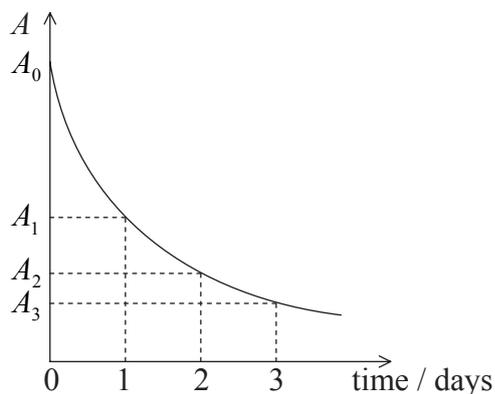
The ratio $\dfrac{A_0}{A_2}$ is equal to which of the following?

A. $\dfrac{A_1}{A_3}$

B. $\dfrac{A_0}{A_3}$

C. $\dfrac{A_0}{2}$

D. $\dfrac{A_3}{3}$

31. The square of the amplitude of the electron wave function in an hydrogen atom is a measure of the

A.   uncertainty in position of the electron.

B.   momentum of the electron.

C.   probability of finding an electron at a particular point.

D.   uncertainty in the velocity.

32. A particle is accelerated from rest through a potential difference V. Which of the following graphs best shows how the de Broglie wavelength λ associated with the particle varies with V?

A.

B.

C.

D.
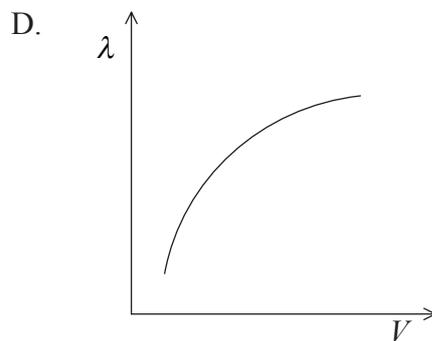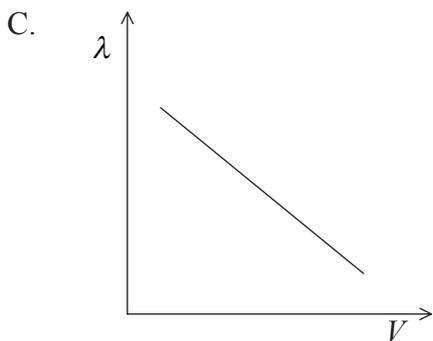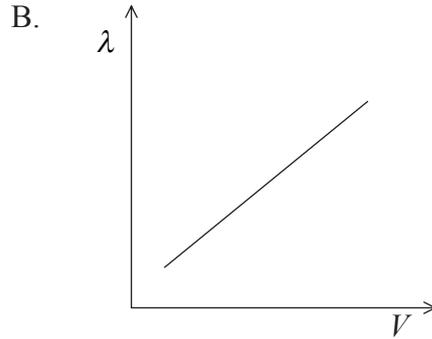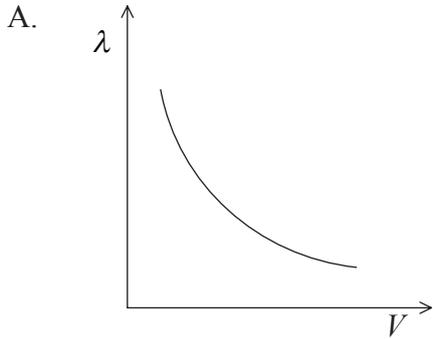
33. Which of the following is a correct statement associated with the photoelectric effect?

A.   Electron emission is instantaneous.

B.   Electrons are only emitted if the incident light is above a certain minimum wavelength.

C.   The energy of the emitted electrons depends on the light intensity.

D.   The energy of the emitted electrons does not depend on the frequency of the incident light.

34. Which of the following energy sources results from the solar energy incident on Earth?

A.   Nuclear fission

B.   Wind energy

C.   Nuclear fusion

D.   Geothermal energy

35. A thermal power station is 20% efficient and generates useful electrical power at 1000 MW. The fossil fuel used has an energy density of $50\,MJ\,kg^{-1}$. The mass of fuel in kg consumed every second is given by which of the following?

    A.   0.01

    B.   0.25

    C.   4

    D.   100

36. Venus and Earth may be regarded as behaving as black bodies. The mean temperature at the surface of Venus is about 600 K and at the surface of Earth is about 300 K. Which of the following is the best estimate for the ratio

$$\frac{\text{power radiated per unit area on Earth}}{\text{power radiated per unit area on Venus}}?$$

    A. $\dfrac{1}{2}$

    B. $\dfrac{1}{4}$

    C. $\dfrac{1}{8}$

    D. $\dfrac{1}{16}$

37. The volume of the Pacific Ocean is V and the volume expansivity of seawater is γ. If the average temperature of the Pacific Ocean increases by ΔT, what would be the fractional increase in volume of the Pacific Ocean?

    A. $\gamma V \Delta T$

    B. $\dfrac{\gamma V}{\Delta T}$

    C. $\gamma \Delta T$

    D. $\dfrac{\gamma}{\Delta T}$

38. Which of the following is likely to increase greenhouse gas concentrations in the atmosphere?

    A.   Using natural gas instead of coal to generate electrical energy

    B.   Incineration of waste to generate electrical energy

    C.   Increased use of wind turbines to generate electrical energy

    D.   Carbon dioxide capture and storage at the power station

39. A laser of wavelength λ is used in a computer to read data from a CD. Which of the following is the appropriate depth of a pit on the CD?

    A. $\dfrac{\lambda}{2}$

    B. $\dfrac{\lambda}{4}$

    C. 2λ

    D. 4λ

40. Increasing the quantum efficiency of a CCD will increase the

    A.   signal strength.

    B.   magnification.

    C.   pixel size.

    D.   resolution.