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PHYSICS
STANDARD LEVEL
PAPER 1

Monday 16 November 2009 (afternoon)

45 minutes

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.   In an experiment to measure the acceleration of free fall at the surface of the Earth the following
      results were obtained.

| Acceleration of free fall / $m s^{-2}$ |
| --- |
| 7.69 |
| 7.70 |
| 7.69 |
| 7.68 |
| 7.70 |

      The results are

      A.   accurate and precise.

      B.   inaccurate but precise.

      C.   accurate but imprecise.

      D.   inaccurate and imprecise.

3.   Two balls of different mass are dropped from the top of a tall building one after the other. The distance
      between the balls

      A.   increases with time.

      B.   depends on the initial velocity only.

      C.   remains constant.

      D.   depends on the mass of the balls.

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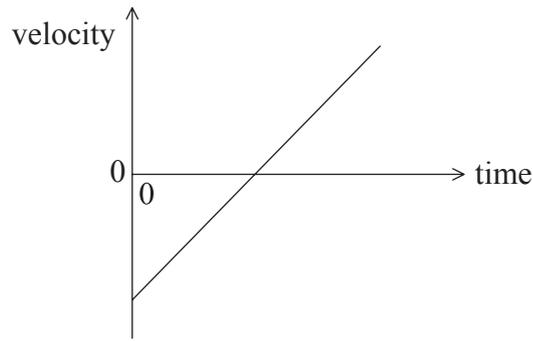
Which of the following graphs correctly shows how the acceleration of the particle varies with time?

A.

B.

C.

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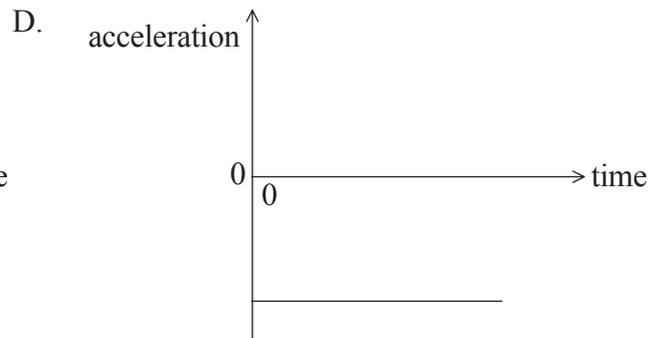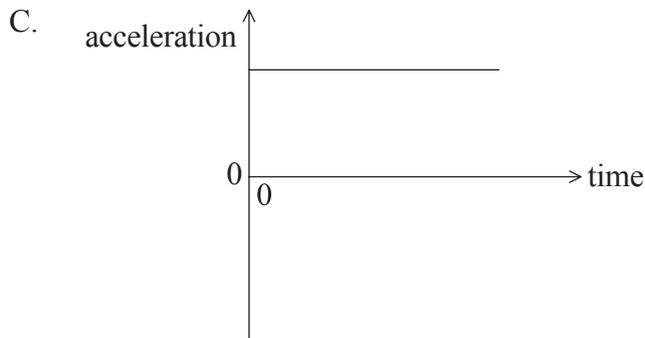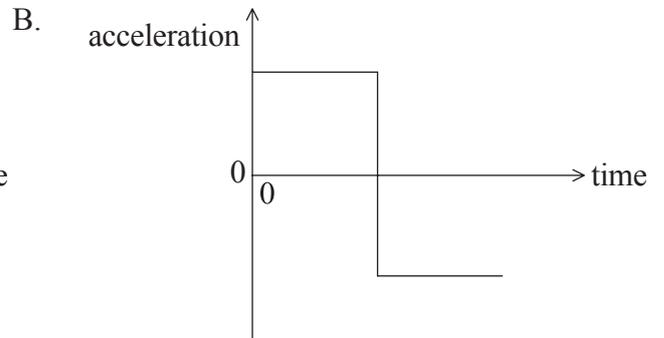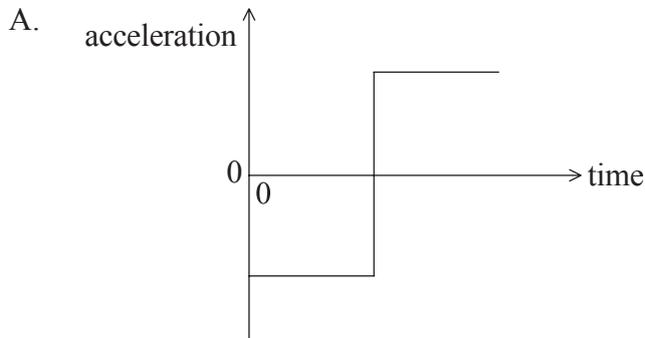
5. An aircraft is flying at constant speed in a horizontal circle. Which of the following diagrams best illustrates the forces acting on the aircraft in the vertical plane?

A.

B.

C.

D.
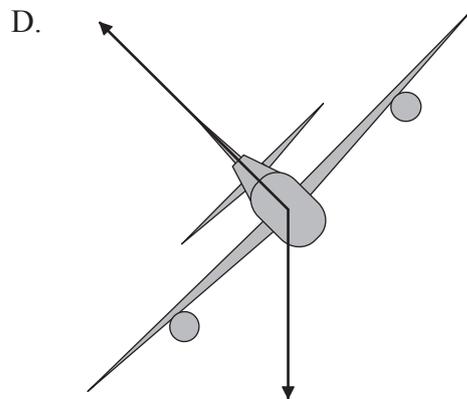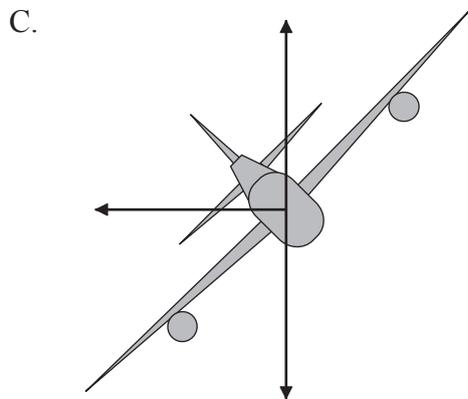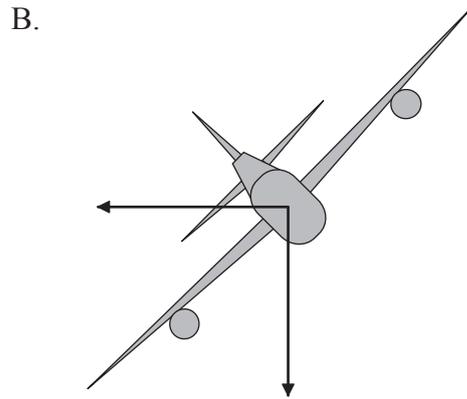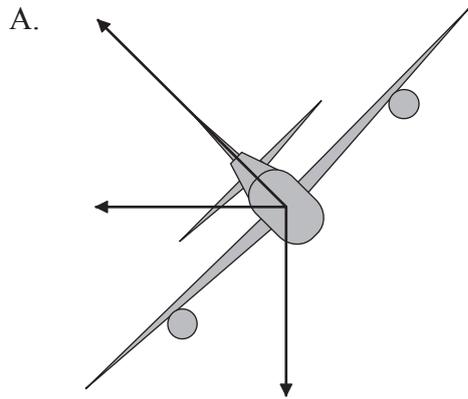
6. For a particle moving at constant speed in a horizontal circle, the work done by the centripetal force is

A.   zero.

B.   directly proportional to the particle mass.

C.   directly proportional to the particle speed.

D.   directly proportional to the (particle speed)^2.

7.   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.

8.   A rubber ball, travelling in a horizontal direction, strikes a vertical wall. It rebounds at right angles to the wall. The graph below illustrates the variation of the ball's momentum p with time t when the ball is in contact with the wall.
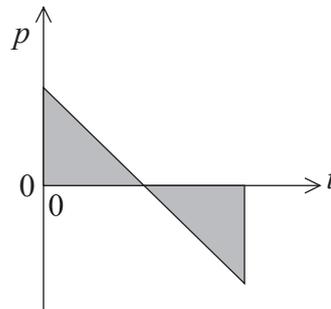
Which of the following statements is true?

    A.   The shaded area is equal to the force exerted by the wall on the ball.

    B.   The shaded area is equal to the force exerted by the ball on the wall.

    C.   The gradient is equal to the force exerted by the wall on the ball.

    D.   The gradient is equal to the force exerted by the ball on the wall.

9. In the table below, which row shows the correct conversion between the Kelvin and Celsius temperature scales?

|	Kelvin temperature / K	Celsius temperature / °C
A.	0	373
B.	100	−173
C.	173	100
D.	373	−100

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. $\dfrac{60}{40}$

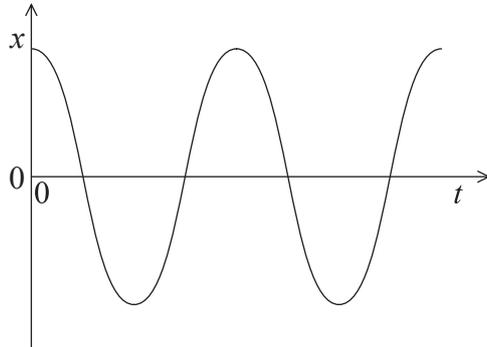**12.** A ray of light is incident on a boundary between glass and air.
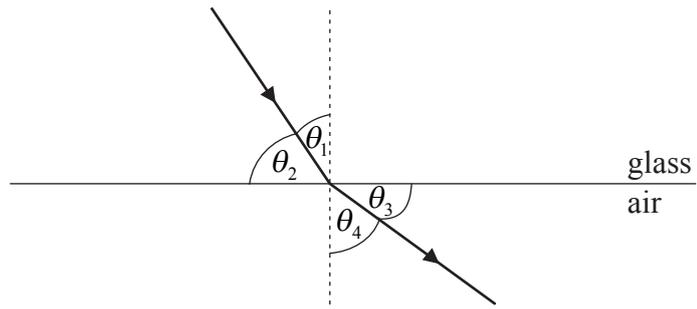


Which of the following is the refractive index of glass?
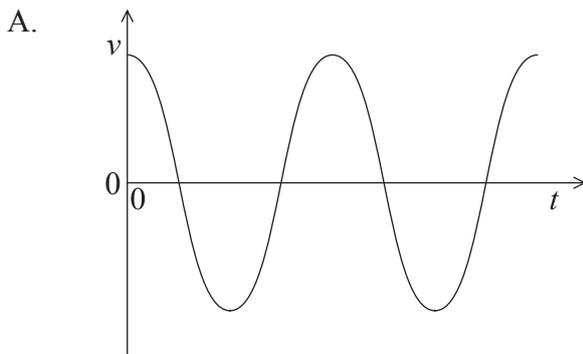
A. $\dfrac{\sin \theta_1}{\sin \theta_3}$

B. $\dfrac{\sin \theta_1}{\sin \theta_4}$

C. $\dfrac{\sin \theta_3}{\sin \theta_2}$

D. $\dfrac{\sin \theta_4}{\sin \theta_1}$

Turn over

*The following graph refers to questions 13 and 14.*

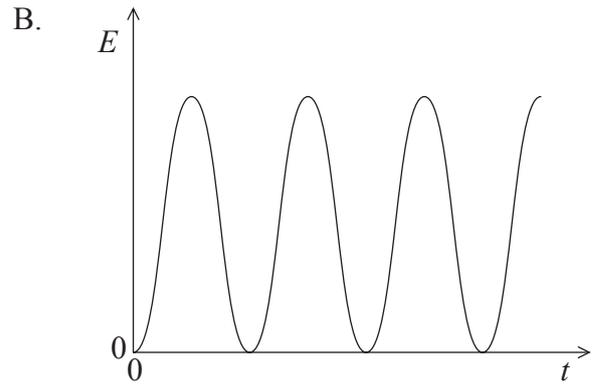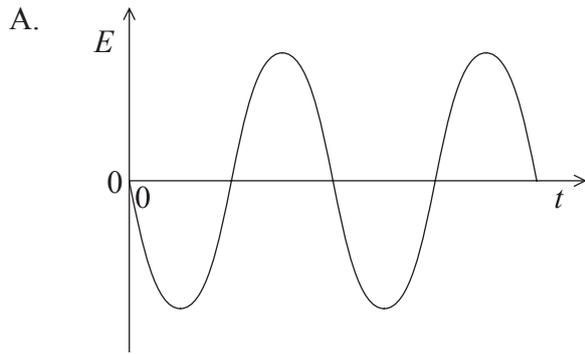The graph below shows how the displacement x of a particle undergoing simple harmonic motion varies with time t. The motion is undamped.

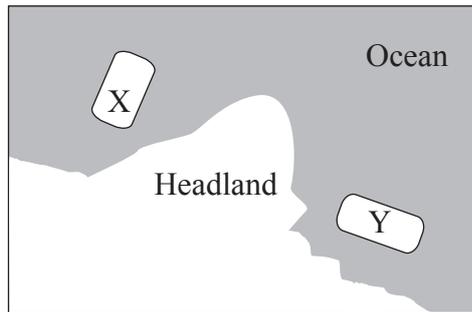**13.** Which of the following graphs correctly shows how the velocity v of the particle varies with t?

A.

B.

C.

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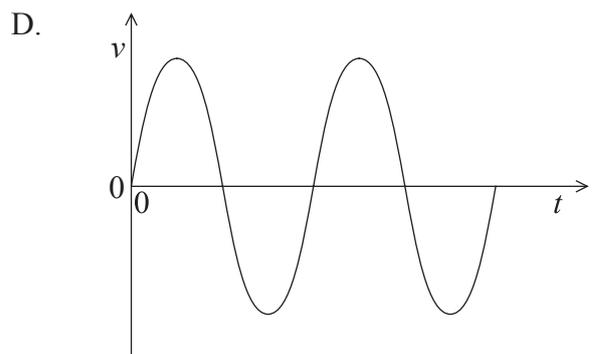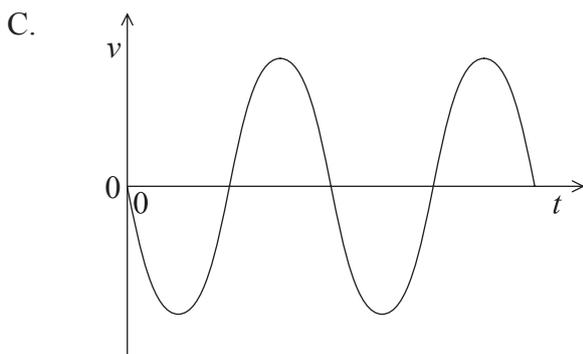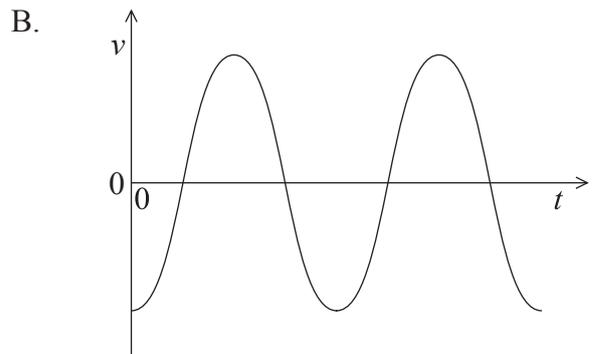
14. Which of the following graphs shows how the total energy E of the particle varies with time t?

A.

B.

C.

D.

Turn over
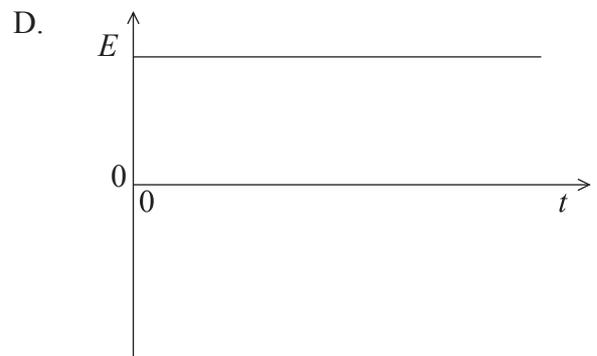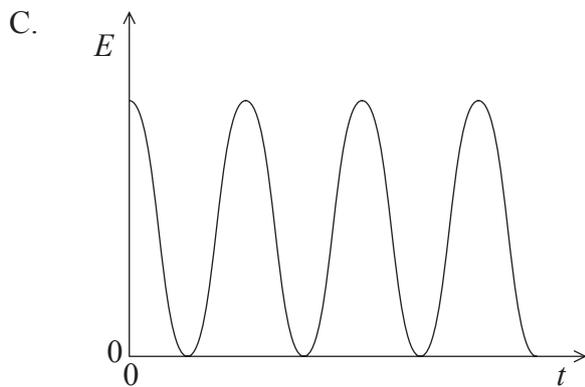
15. An orchestra playing on boat X can be heard by tourists on boat Y, which is situated out of sight of boat X around a headland.

The sound from X can be heard on Y due to

A.   refraction.

B.   reflection.

C.   diffraction.

D.   transmission.

16. A cell of emf ε and internal resistance r delivers current to a small electric motor.
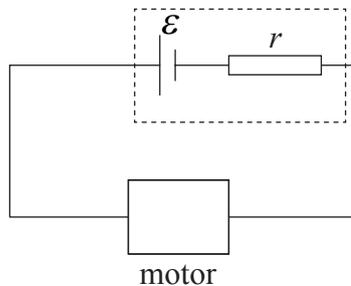
450 C of charge flows through the motor and 9000 J of energy are converted in the motor. 1800 J are dissipated in the cell. The emf of the cell is

A.   4.0 V.

B.   16 V.

C.   20 V.

D.   24 V.

17. 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
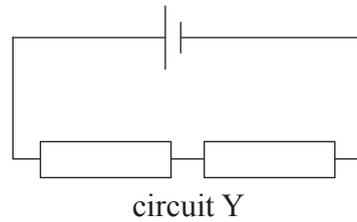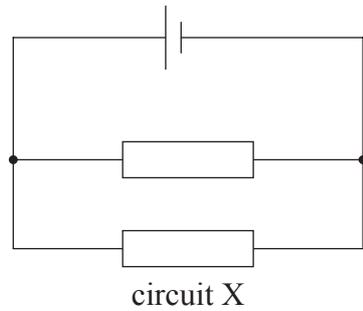
    A. $2R$.

    B. R.

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

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

18. In the circuits below the cells have the same emf and zero internal resistance. The resistors all have the same resistance.

circuit X

circuit Y

Which of the following gives the ratio $\dfrac{\text{power dissipated in X}}{\text{power dissipated in Y}}$?

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

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

    C.   2

    D.   4

Turn over

19. A small sphere X of mass M is placed a distance d from a point mass. The gravitational force on sphere X is 90 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
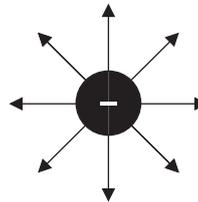
    A.   480 N.

    B.   160 N.

    C.   120 N.

    D.   40 N.

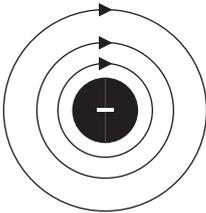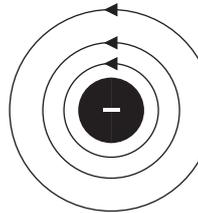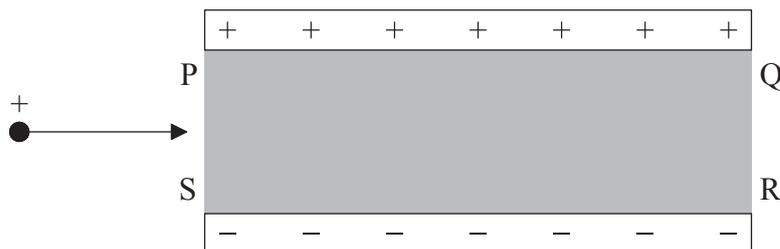**20.** Which of the following diagrams illustrates the electric field pattern of a negatively charged sphere?
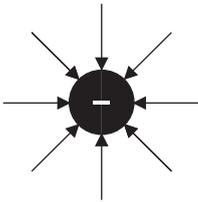
21. A positively charged particle enters the space between two charged conducting plates, with a constant velocity directed parallel to the plates, as shown.

The top plate is positively charged and the bottom plate is negatively charged. There is a magnetic field in the shaded region PQRS. The particle continues to move in a horizontal straight line between the plates. Which of the following correctly describes the magnetic field direction?

A.   Into plane of paper

B.   Out of plane of paper

C.   Up

D.   Down

22. 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. $N=A+Z$.

23. 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.

24. A radio-isotope has an activity of 400 Bq and a half-life of 8 days. After 32 days the activity of the sample is

A.   200 Bq.

B.   100 Bq.

C.   50 Bq.

D.   25 Bq.

25. 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

26. Which of the following is a renewable and non-renewable energy source?

	Renewable	**Non-renewable**
A.	uranium	coal
B.	tidal	uranium
C.	uranium	biogas
D.	natural gas	biogas

27. 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

28. 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

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

Turn over

30. In a nuclear power station, a moderator is required to

A. control the rate of fission.

B. reduce heat losses to the surroundings.

C. reduce the energy of high energy neutrons.

D. increase the energy of low energy neutrons.