ib Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Monday 9 November 2015 (morning)

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.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

International Baccalaureate
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1. Which of the following is a derived unit?

    A.   Mole

    B.   Kelvin

    C.   Coulomb

    D.   Ampere

2. One kilogram of ice of density $1000\,kg\,m^{-3}$ is frozen in the shape of a cube. The diameter of a water molecule is $10^{-10}\,m$. What is the difference in the orders of magnitude of the length of one side of the ice cube and the diameter of a water molecule?

    A.   7

    B.   9

    C.   11

    D.   13

3. An object is at rest at time $t=0$. The variation with t of the acceleration a of the object is shown from $t=0$ to $t=20\,s$.
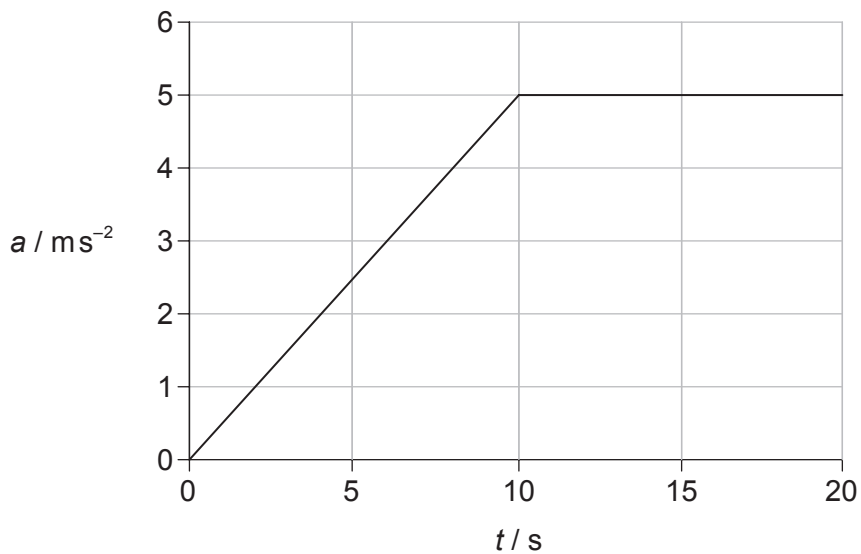
What is the speed of the object when $t=15\,s$?

    A. $25\,m\,s^{-1}$

    B. $50\,m\,s^{-1}$

    C. $75\,m\,s^{-1}$

    D. $100\,m\,s^{-1}$

4. Which of the following is proportional to the net external force acting on a body?

A.   Speed

B.   Velocity

C.   Rate of change of speed

D.   Rate of change of velocity

5. A small positively charged sphere is suspended from a thread and placed close to a negatively charged rod. When the thread is at 45° to the vertical the system is in equilibrium. The weight of the sphere is W and the magnitude of the electrostatic force between the rod and the sphere is F.
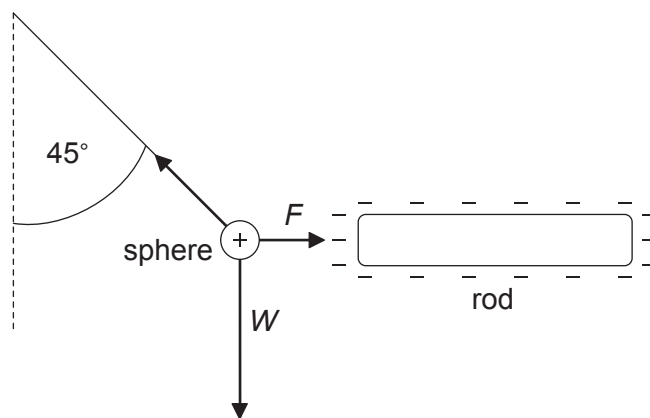
(not to scale)

What is the magnitude of W compared with the magnitude of F?

A. $W = \sqrt{2}F$

B. $F < W < \sqrt{2}F$

C. $W = F$

D. $W > F$

6. An object of mass m is initially at rest. When an impulse I acts on the object its final kinetic energy is E_K. What is the final kinetic energy when an impulse of $2I$ acts on an object of mass $2m$ initially at rest?

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

B. E_K

C. $2E_K$

D. $4E_K$

Turn over

7. A heat engine does 300 J of work during one cycle. In this cycle 900 J of energy is wasted. What is the efficiency of the engine?

    A.   0.25

    B.   0.33

    C.   0.50

    D.   0.75

8. A container holds 40 g of argon-40 $\left(^{40}_{18}Ar\right)$ and 8 g of helium-4 $\left(^{4}_{2}He\right)$.

What is the $\dfrac{\text{number of atoms of argon}}{\text{number of atoms of helium}}$ in the container?

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

    B. $\dfrac{2}{9}$

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

    D. $\dfrac{9}{2}$

9. The thermal capacity of a body is the energy required to change the temperature of the body by

    A. $1\,K$.

    B. $1\,K\,m^3$.

    C. $1\,K\,kg^{-1}$.

    D. $1\,K\,s^{-1}$.

10. When 1800 J of energy is supplied to a mass m of liquid in a container, the temperature of the liquid and the container changes by 10 K. When the mass of the liquid is doubled to $2m$, 3000 J of energy is required to change the temperature of the liquid and container by 10 K. What is the specific heat capacity of the liquid in $J\,kg^{-1}\,K^{-1}$?

A. $\dfrac{60}{m}$

B. $\dfrac{120}{m}$

C. $\dfrac{180}{m}$

D. $\dfrac{240}{m}$

11. Two objects are in thermal contact and are at different temperatures. What is/are determined by the temperatures of the two objects?

     I.   The direction of thermal energy transfer between the objects

     II.   The quantity of internal energy stored by each object

     III.   The process by which energy is transferred between the objects

A. I only

B. II only

C. I and II only

D. I, II and III

12. The period of a particle undergoing simple harmonic motion (SHM) is T.

The ratio $\dfrac{\text{acceleration of the particle}}{\text{displacement of the particle from its equilibrium position}}$ is proportional to

A. T^{-2}.

B. T^{-1}.

C. T.

D. T^{2}.

Turn over

13. A particle of mass *m* oscillates with simple harmonic motion (SHM) of angular frequency ω. The amplitude of the SHM is *A*. What is the kinetic energy of the particle when it is half way between the equilibrium position and one extreme of the motion?

A. $\dfrac{mA^2\omega^2}{4}$

B. $\dfrac{3mA^2\omega^2}{8}$

C. $\dfrac{9mA^2\omega^2}{32}$

D. $\dfrac{15mA^2\omega^2}{32}$

14. A transverse travelling wave has an amplitude x_0 and wavelength λ. What is the minimum distance between a crest and a trough measured in the direction of energy propagation?

A. $2x_0$

B. x_0

C. λ

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

15. A wave on a string travels to the right as shown. The frequency of the wave is f. At time $t = 0$, a small marker on the string is in the position shown.

What is the position of the marker at $t = \dfrac{1}{4f}$?
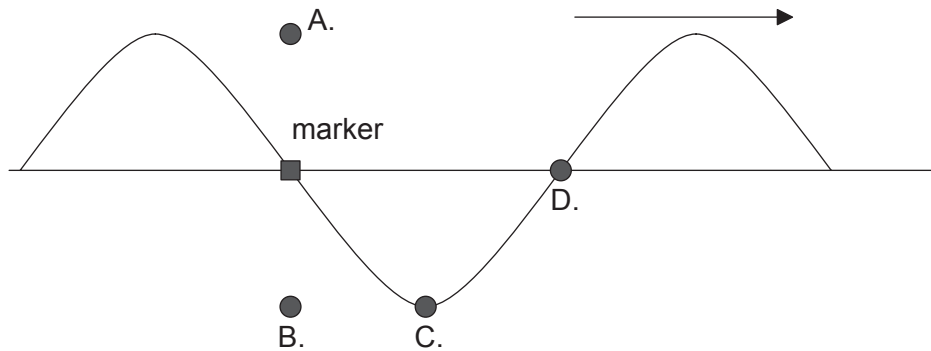

16. Electromagnetic waves

A.   always obey an inverse square law.

B.   are made up of electric and magnetic fields of constant amplitude.

C.   always travel at the same speed in a vacuum.

D.   are always polarized.

17. A wave pulse travels along a light string which is attached to a frictionless ring. The ring can move freely up and down a vertical rod.
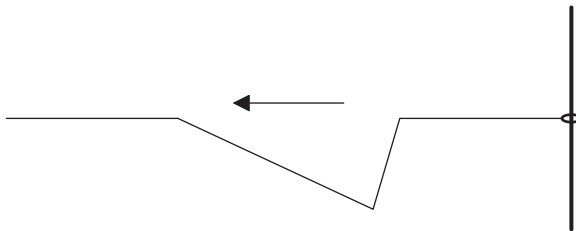
rod

string

ring
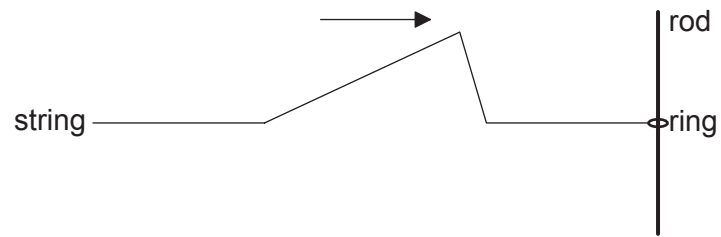
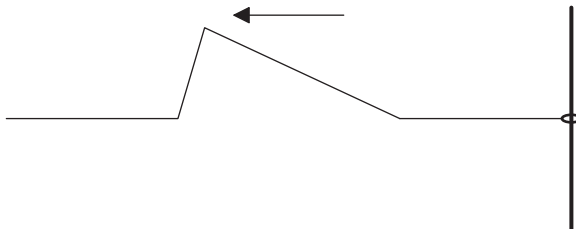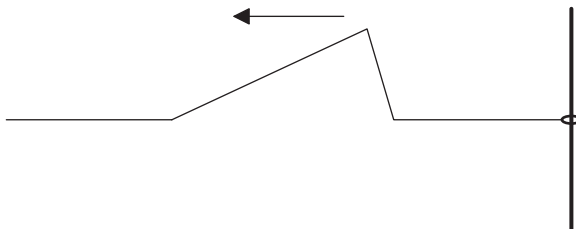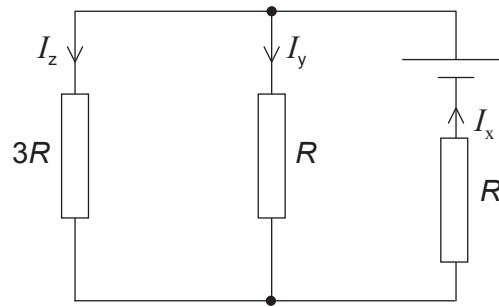What is the shape of the wave pulse after reflection?

A.
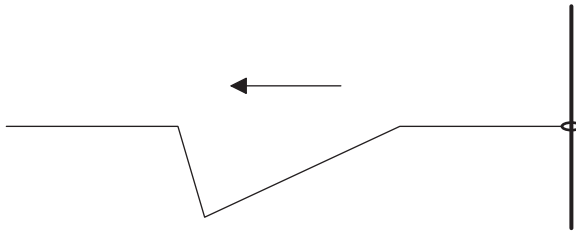
B.

C.

D.

18. Resistors of resistance R, R and $3R$ are connected to a cell of negligible internal resistance. The diagram shows three currents I_x, I_y and I_z in the resistors.

Which is a correct relationship between the currents?

A. $I_x = I_y$

B. $I_y = 3I_z$

C. $I_z = 3I_x$

D. $I_x = I_y + 3I_z$

19. A cylindrical resistor of length l is made from a metal of mass m. It has a resistance R.

Two resistors, each of length $2l$ and mass $\dfrac{m}{2}$, are then created from the same volume of the metal.

What is the resistance of the two resistors when connected in parallel?

A. R

B. $2R$

C. $4R$

D. $8R$

20. Three resistors of resistance R are connected in parallel across a cell of electromotive force (emf) V that has a negligible internal resistance. What is the rate at which the cell supplies energy?

A. $\dfrac{V^2}{3R}$

B. $\dfrac{V^2}{9R}$

C. $\dfrac{9V^2}{R}$

D. $\dfrac{3V^2}{R}$

21. What is the correct definition of gravitational field strength?

A. The mass per unit weight

B. The weight of a small test mass

C. The force acting on a small test mass

D. The force per unit mass acting on a small test mass

**22.** A $+3\,\text{C}$ charge and a $-4\,\text{C}$ charge are a distance x apart. P is a distance x from the $+3\,\text{C}$ charge on the straight line joining the charges.
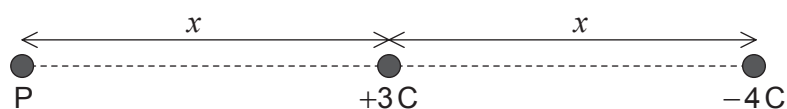
What is the magnitude of the electric field strength at P?

A. $\dfrac{1}{\pi \varepsilon_0 x^2}$

B. $\dfrac{1}{2\pi \varepsilon_0 x^2}$

C. $\dfrac{1}{4\pi \varepsilon_0 x^2}$

D. $\dfrac{1}{7\pi \varepsilon_0 x^2}$

23. An electron is moving parallel to a straight current-carrying wire. The direction of conventional current in the wire and the direction of motion of the electron are the same. In which direction is the magnetic force on the electron?
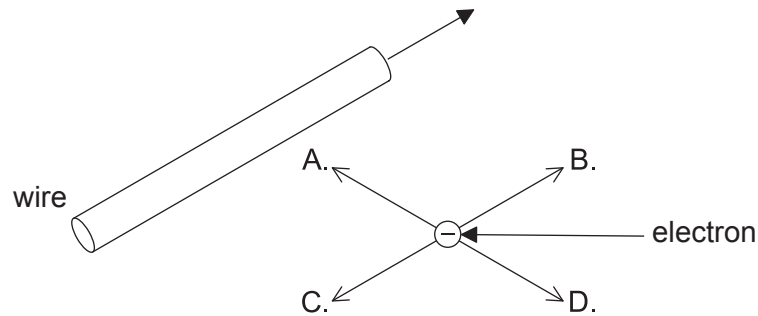
24. A simple model of the hydrogen atom suggests that the electron orbits the proton. What is the force that keeps the electron in orbit?

A.   Electrostatic

B.   Gravitational

C.   Strong nuclear

D.   Centripetal

25. Bismuth-210 $\left(^{210}_{83}\text{Bi}\right)$ is a radioactive isotope that decays as follows.

$$^{210}_{83}\text{Bi} \xrightarrow{\beta^-} \text{X} \xrightarrow{\alpha} \text{Y}$$
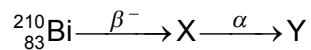
What are the mass number and proton number of Y?

	Mass number	Proton number
A.	206	86
B.	206	82
C.	210	82
D.	214	83

Turn over

26. For fissile material, fuel enrichment is the

    A.   increase in the ratio of $\dfrac{\text{uranium-235}}{\text{uranium-238}}$.

    B.   conversion of uranium-235 to uranium-238.

    C.   conversion of uranium-238 to plutonium-239.

    D.   increase in the ratio of $\dfrac{\text{uranium-238}}{\text{uranium-235}}$.

27. It is suggested that the solar power incident at a point on the Earth's surface depends on

    I.   daily variations in the Sun's power output
    II.   the location of the point
    III.   the cloud cover at the point.

Which suggestion(s) is/are correct?

    A.   III only

    B.   I and II only

    C.   II and III only

    D.   I, II and III

28. Waves are incident on an oscillating water column (OWC) ocean-wave energy converter with an available power P. What is the available power for this converter when the wave amplitude is halved and the wave speed is doubled?

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

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

    C. P

    D. $4P$

29. The average surface temperature of Mars is about $200\,\text{K}$. The average surface temperature of Earth is about $300\,\text{K}$. Both can be regarded as black bodies.

What is the ratio $\dfrac{\text{energy radiated per second per unit area on Mars}}{\text{energy radiated per second per unit area on Earth}}$?

A.   0.7

B.   0.4

C.   0.3

D.   0.2

30. In an energy-balance climate model, the power of the incoming radiation over an area A is P_i and the power of the outgoing radiation over the same area is P_o. The surface heat capacity is C_s. What is the time taken to increase the temperature of the area by θ?

A. $\dfrac{(P_i - P_o)}{C_s\theta}$

B. $\dfrac{C_s\theta}{(P_i - P_o)}$

C. $\dfrac{AC_s\theta}{(P_i - P_o)}$

D. $\dfrac{A(P_i - P_o)}{C_s\theta}$