22136507

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

PHYSICS
HIGHER LEVEL
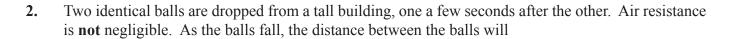**PAPER 1**

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.   The mass of an elephant is $10^4\,kg$. The mass of a mouse is $10^{-2}\,kg$. What is the ratio

$$\frac{\text{mass of the elephant}}{\text{mass of the mouse}}?$$

A. 10^{-8}

B. 10^{-6}

C. 10^6

D. 10^8

2.   Two identical balls are dropped from a tall building, one a few seconds after the other. Air resistance is **not** negligible. As the balls fall, the distance between the balls will
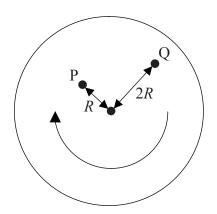
A.   decrease.

B.   increase.

C.   increase then remain constant.

D.   remain constant.

3.   Which of the following is always true for an object moving in a straight line at constant speed?

A.   No forces act on the object.

B.   No resultant force acts on the object.

C.   The momentum of the object is zero.

D.   No work is being done on the object.

4. Object A of mass m is lifted through a height h. Object B of mass $2m$ is lifted through a height $4h$. The gravitational field is constant over the height interval. What is the ratio

$$\frac{\text{work done against gravity on object B}}{\text{work done against gravity on object A}} \; ?$$

A.   1

B.   2

C.   4

D.   8

5. A horizontal disc is rotating about a vertical axis through its centre. Points P and Q on the disc are at distances R and $2R$ respectively from the centre.

The acceleration at P is a. Which of the following is the acceleration at Q?

A. $0.5a$

B. a

C. $2a$

D. $4a$

Turn over

6.   4.0 kg of water at $100\,^\circ$C is mixed with 1.0 kg of water at $0\,^\circ$C in a container insulated from the surroundings. Which of the following is the final temperature of the water?

A. $20\,^\circ$C

B. $25\,^\circ$C

C. $75\,^\circ$C

D. $80\,^\circ$C

7.   Which of the following is the temperature of an object related to?

A.   The kinetic energy of the object

B.   The random kinetic energy of the particles in the object

C.   The potential energy of the particles in the object

D.   The sum of the random kinetic energy and potential energy of the particles in the object

8.   A fixed mass of gas is compressed in a very short period of time. Which of the following describes this process?

A.   Adiabatic

B.   Isobaric

C.   Isochoric (isovolumetric)

D.   Isothermal

9.   Which of the following statements is consistent with the second law of thermodynamics?

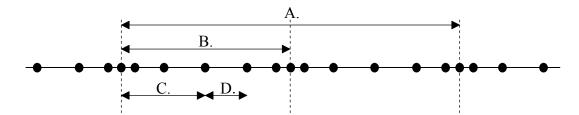A.   Thermal energy can flow by itself from a cold to a hot body.

B.   A heat engine can be 100% efficient.

C.   In natural processes, total entropy tends to increase.
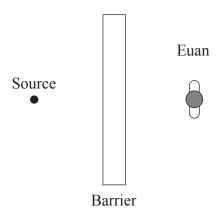
D.   The entropy in every closed system is constant.

10. Microwave ovens cause the water molecules in food to resonate. Water molecules have a natural frequency of vibration f. In order to heat the food most effectively, the frequency of the microwaves should have a value

   A.   less than f.

   B.   equal to f.

   C.   greater than f.

   D.   as large as possible.

11. Gas particles are equally spaced along a straight line. A sound wave passes through the gas. The positions of the gas particles at one instant are shown below.

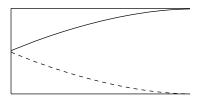Which of the distances shown is equal to the wavelength of the wave?

Turn over

12. A point source of sound is placed behind a soundproof barrier as shown in the diagram.

From where Euan is standing he can hear the sound. Which of the following best explains this observation?

A.　Diffraction
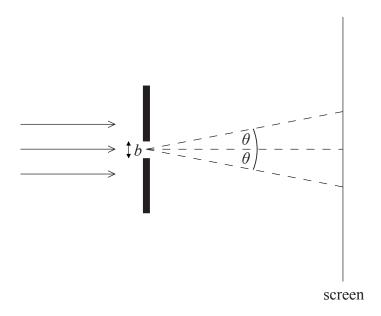
B.　Interference

C.　Polarization

D.　Refraction

13. A standing wave of frequency f is established in air in a pipe open at one end, as shown.

Which of the following is the frequency of the next highest harmonic?

A.　$\dfrac{f}{3}$

B.　$\dfrac{f}{2}$

C.　$2f$

D.　$3f$

14. A sample of hydrogen on Earth emits a spectral line that is measured by an Earth observer to have wavelength 500 nm. The same spectral line is emitted by a galactic source that is moving away from Earth at speed of 0.1c. What is the wavelength of the galactic spectral line that will be measured by the Earth observer?

A.   50 nm

B.   450 nm

C.   550 nm

D.   5000 nm

15. A parallel beam of monochromatic light of wavelength λ passes through a slit of width b and forms a diffraction pattern on a screen far from the slit. The angle at which the first diffraction minimum is formed is θ.
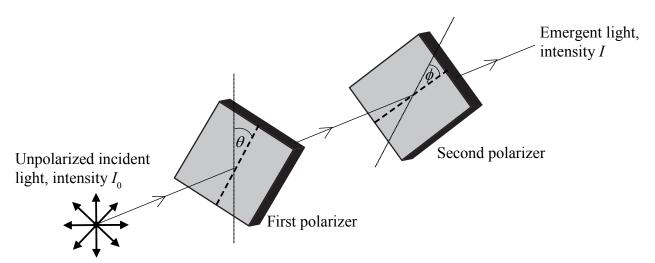

screen

Which of the following changes in λ and b, carried out separately, will increase the value of θ?

	λ	b
A.	decrease	increase
B.	increase	increase
C.	decrease	decrease
D.	increase	decrease

Turn over

16. Two coloured point sources are observed through an optical telescope. Which of the following colours for the sources would best allow their images to be resolved?

    A.   Blue

    B.   Green

    C.   Red

    D.   Yellow

17. Unpolarized light of intensity I_0 is transmitted through a polarizer which has a transmission axis at an angle θ to the vertical. The light is then incident on a second polarizer with a transmission axis at an angle ϕ to the transmission axis of the first polarizer, as shown below.
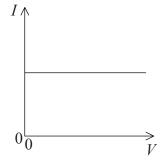

The intensity of the light that emerges from the second polarizer is I. What is the ratio $\dfrac{I}{I_0}$?
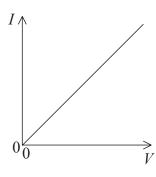
    A.   0.25

    B. $0.5\cos^2(\theta+\phi)$

    C. $0.5\cos^2\phi$

    D. $\cos^2\theta\cos^2\phi$

18. Which of the following graphs shows the relationship between current I and voltage V for a filament lamp?
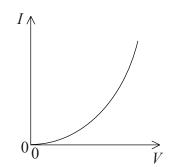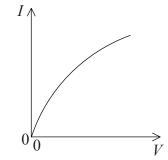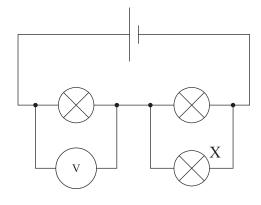
A.

B.

C.

D.

19. A cell of negligible internal resistance is connected to three identical lamps. A voltmeter is connected across one of the lamps.

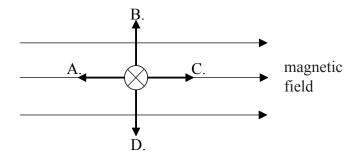If the filament in lamp X breaks, the reading on the voltmeter will

A. become zero.

B. decrease.

C. stay the same.

D. increase.

Turn over

20. Two point charges of size $+2q$ and $-q$ are placed as shown below. In which of the regions I, II and III can the resultant electric field strength be zero?
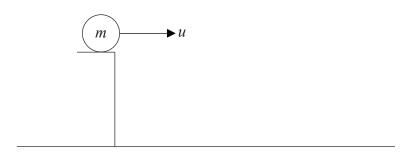
$$+2q \qquad\qquad -q$$

I ·········●········· II ·········●········· III

A.   I only

B.   II only

C.   III only

D.   I and III only

21. A wire is placed in a magnetic field which is directed to the right. The wire carries a current directed into the page. Which of the following is the direction of the force on the wire?

B.

A.   ⊗   C.   magnetic field

D.

22. A ball of mass m is thrown horizontally from a cliff with initial velocity u. Air resistance is negligible.

m → u
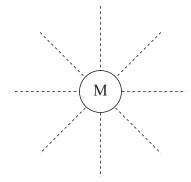
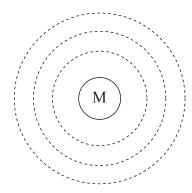A change in which of the following will affect the horizontal distance travelled?

A. m only

B. u only

C.   both m and u

D.   neither m nor u

23. M is a spherical mass situated far away from any other masses. Which of the following represents gravitational equipotential surfaces having constant potential difference between them?

A.

B.

C.

D.

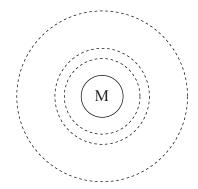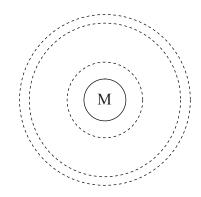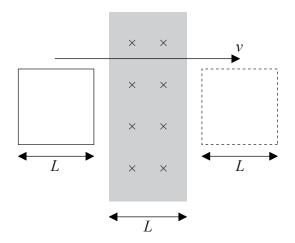**24.** A satellite is moved from a low orbit to a higher orbit. Which of the following accurately describes the energy of the satellite?

	Total energy	Gravitational potential energy	Kinetic energy
A.	stays the same	decreases	increases
B.	stays the same	increases	decreases
C.	increases	decreases	increases
D.	increases	increases	decreases

25. A uniform magnetic field directed into the page occupies a region of width L. A conducting coil of width L moves at constant speed v, from left to right, through the field.

From the instant that the coil enters the field until the instant that the coil leaves the field, which of the following best describes the direction of the current induced in the coil?

A. Anti-clockwise

B. Clockwise

C. Anti-clockwise then clockwise

D. Clockwise then anti-clockwise

26. An ideal transformer has 200 turns of wire on the primary coil and 600 turns on the secondary coil. There is an alternating potential difference of frequency f and of peak value V across the primary coil. Which of the following best describes the emf across the secondary coil?

	Peak emf	Frequency
A.	less than V	less than f
B.	less than V	equal to f
C.	greater than V	greater than f
D.	greater than V	equal to f

27. Which of the following would decrease the initial activity of a sample of plutonium?

    A.   Placing the sample in a lead container

    B.   Placing the sample in a dark room

    C.   Decreasing the mass of the sample

    D.   Decreasing the temperature of the sample

28. The reaction $^{14}_{7}\text{N} + ^{4}_{2}\alpha \rightarrow ^{17}_{8}\text{O} + ^{1}_{1}\text{p}$ is an example of

    A.   alpha decay.

    B.   artificial transmutation.

    C.   nuclear fusion.

    D.   proton decay.

29. An electron accelerated from rest through a potential difference V has de Broglie wavelength λ. What is the wavelength of an electron accelerated from rest through a potential difference of $2V$?

    A. 2λ

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

    C. $\sqrt{2}\lambda$

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

30. Which of the following correctly shows the energy levels associated with the "electron in a box" model?
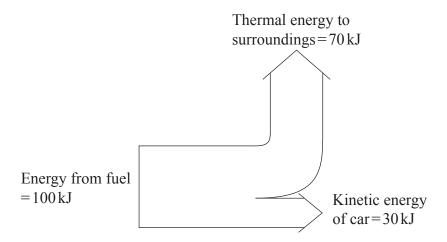
A.   Energy

B.   Energy

C.   Energy

D.   Energy

31. The Bainbridge mass spectrometer provides evidence for the existence of

A.   atomic energy levels.

B.   nuclear energy levels.

C.   isotopes.

D.   the nucleus.

32. A radioactive sample of initial activity 12.0 Bq has a half-life of 3.0 days. Which of the following is the activity after 4.0 days?

A.   3.0 Bq

B.   3.8 Bq

C.   4.0 Bq

D.   4.8 Bq

33. The diagram below shows an energy flow diagram (Sankey diagram) for a car.

Thermal energy to
surroundings = 70 kJ

Energy from fuel
= 100 kJ

Kinetic energy
of car = 30 kJ

What is the efficiency of the car?

A.   30 %

B.   40 %

C.   70 %

D.   100 %

Turn over

34. A small biofuel power station burns ethanol with an overall efficiency of 25%. The energy density of ethanol is $30\,MJ\,kg^{-1}$. The mass of fuel consumed every second is $50\,kg$. Which of the following gives the useful power output in MW?

A. $\dfrac{30 \times 50 \times 25}{100}$

B. $\dfrac{30 \times 50 \times 100}{25}$

C. $\dfrac{30 \times 25}{50 \times 100}$

D. $\dfrac{30 \times 100}{50 \times 25}$

35. In a nuclear fission reactor, the role of the moderator is to

A. absorb neutrons to shut down the reactor.

B. speed neutrons up to increase the rate of energy production.

C. slow neutrons down to decrease the rate of energy production.

D. slow neutrons down to make a chain reaction more likely.

36. Carbon dioxide is a greenhouse gas because

A. it absorbs infrared light radiated by the Sun.

B. it absorbs ultraviolet light radiated by the Earth.

C. its natural frequency molecular oscillation lies in the infrared region.

D. its natural frequency molecular oscillation lies in the ultraviolet region.

37. Which of the following is most likely to increase the rate of global warming?

    A.   Deforestation

    B.   Increasing the use of nuclear power stations

    C.   Increasing the use of renewable energy sources

    D.   Using natural gas instead of coal for electricity generation

38. In the following four-digit binary number, which digit is the most significant bit?

0	1	1	0
A.	B.	C.	D.

39. The playing time of an audio compact disc (CD) in seconds is t. The data are retrieved at a rate of f samples per second. Each sample contains b bits. Which of the following gives the number of bits stored on the CD?

    A. $\dfrac{t}{fb}$

    B. $\dfrac{tf}{b}$

    C. $\dfrac{tb}{f}$

    D. tfb

40. A square CCD has a certain number of pixels, each separated by a certain distance. What would be the effect on the magnification and resolution of using a CCD with the same number of pixels, but spaced closer together?

	Magnification	**Resolution**
A.	no effect	no effect
B.	no effect	increased
C.	increased	no effect
D.	increased	increased