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**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Wednesday 7 May 2014 (morning)

1 hour

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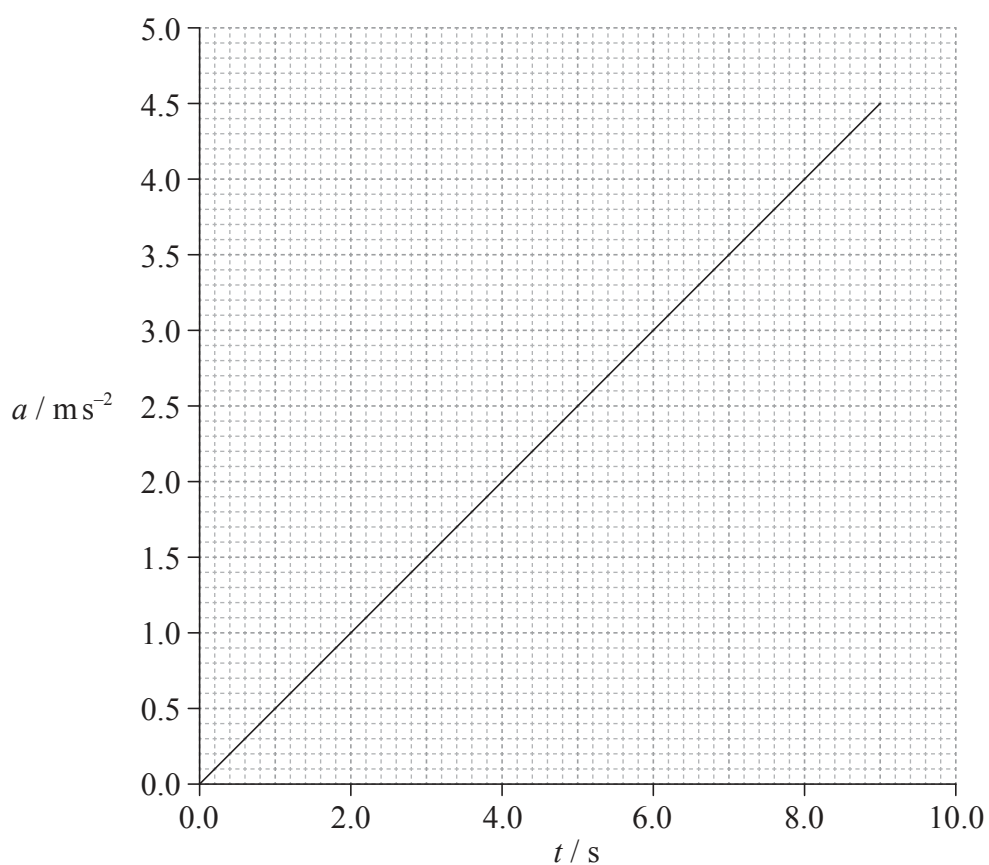
**INSTRUCTIONS TO CANDIDATES**

- 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 is a unit of energy?

- A.  $\text{kg m}^{-1} \text{s}^{-1}$
- B.  $\text{kg m}^2 \text{s}^{-2}$
- C.  $\text{kg m s}^{-2}$
- D.  $\text{kg m}^2 \text{s}^{-1}$

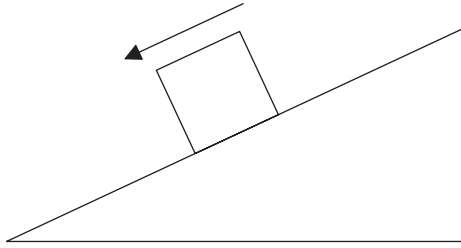
2. A particle accelerates from rest. The graph shows how the acceleration  $a$  of the particle varies with time  $t$ .



What is the speed of the particle at  $t=6.0$  s?

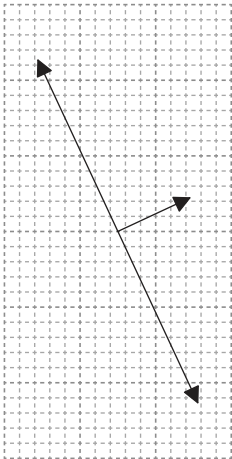
- A.  $0.5 \text{ ms}^{-1}$
- B.  $2.0 \text{ ms}^{-1}$
- C.  $9.0 \text{ ms}^{-1}$
- D.  $18 \text{ ms}^{-1}$

3. A block slides down an inclined plane at constant speed.

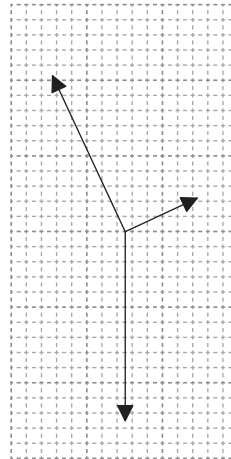


Which diagram represents the free-body diagram of the forces acting on the block?

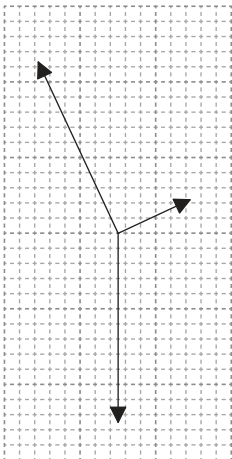
A.



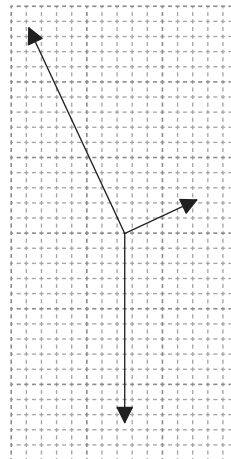
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C.

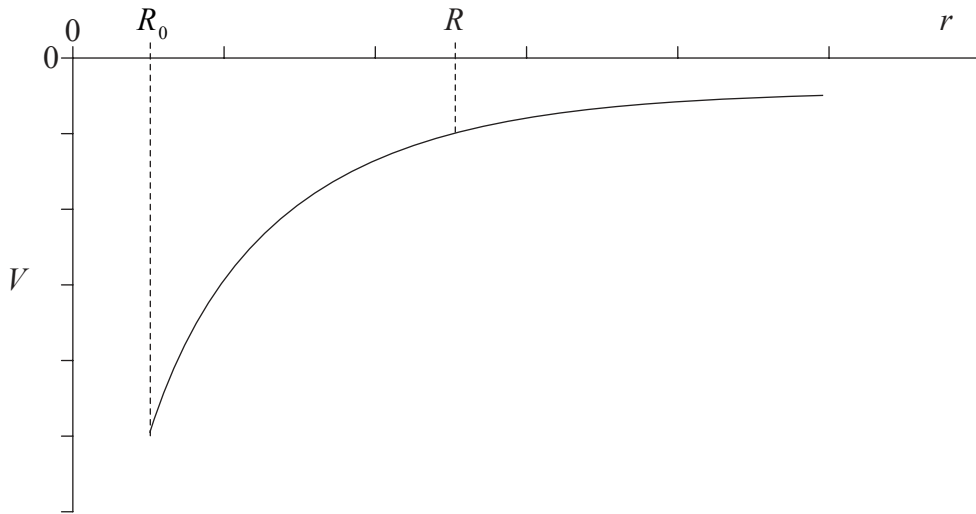


D.



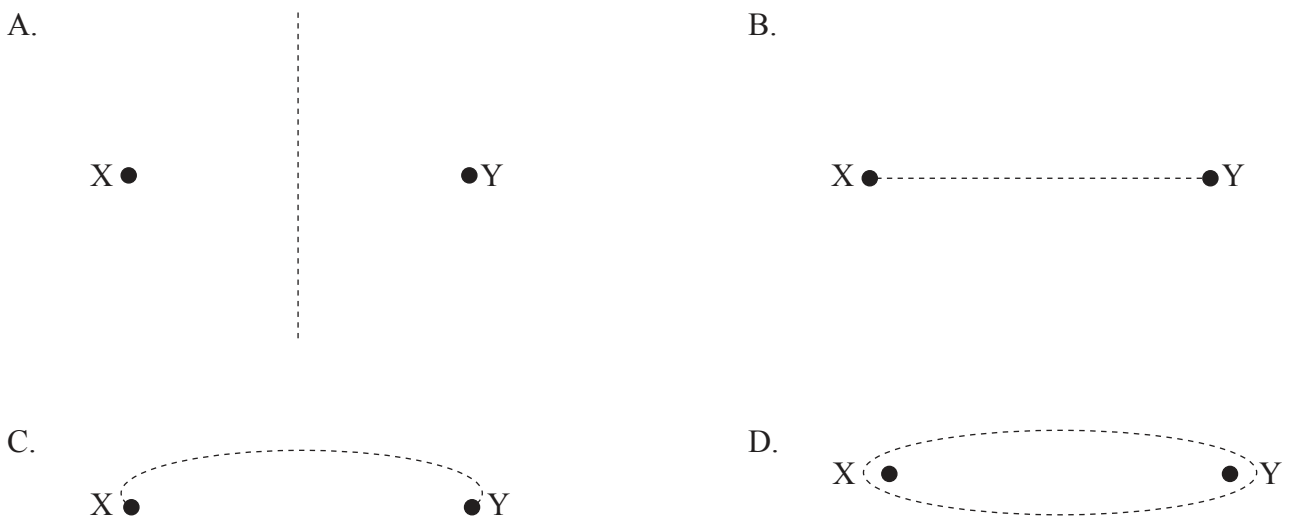
4. In the collision between two bodies, Newton's third law
- A. only applies if momentum is conserved in the collision.
  - B. only applies if energy is conserved in the collision.
  - C. only applies if both momentum and energy are conserved in the collision.
  - D. always applies.
5. A truck is pulled up an inclined plane at constant speed by an electric motor. The gain in potential energy of the truck is 48 kJ. The efficiency of the electric motor is  $\frac{2}{3}$ .
- How much energy is dissipated in pulling the truck up the plane?
- A. 16 kJ
  - B. 24 kJ
  - C. 32 kJ
  - D. 64 kJ
6. A projectile is fired from level ground with speed  $v$  at an angle  $\theta$  to the ground. Ignoring air resistance, which of the following is a correct expression for the maximum height reached by the projectile?
- A.  $\frac{v^2 \sin^2 \theta}{2g}$
  - B.  $\frac{v^2 \cos^2 \theta}{2g}$
  - C.  $\frac{v \sin \theta}{g}$
  - D.  $\frac{v \cos \theta}{g}$

7. The sketch graph shows how the gravitational potential  $V$  of a planet varies with distance  $r$  from the centre of the planet of radius  $R_0$ .



The magnitude of the gravitational field strength at the point  $r=R$  equals the

- A. area between the graph and the  $r$ -axis between  $r=R$  and  $r=R_0$ .
  - B. gradient of the graph at  $r=R$ .
  - C. inverse of the gradient of the graph at  $r=R$ .
  - D. value of  $V$  at  $r=R$  divided by  $R^2$ .
8. Which diagram shows a correct equipotential line due to two point charges X and Y of opposite sign?



9. Two objects are in thermal contact. For there to be no net transfer of thermal energy between the objects they must
- A. have the same thermal capacity and be at the same temperature.
  - B. have the same thermal capacity only.
  - C. have the same mass and be at the same temperature.
  - D. be at the same temperature only.
10. The specific latent heat is the energy required to change the phase of
- A. one kilogram of a substance.
  - B. a substance at constant temperature.
  - C. a liquid at constant temperature.
  - D. one kilogram of a substance at constant temperature.
11. Two containers, X and Y, are each filled by an ideal gas at the same temperature. The volume of Y is half the volume of X. The number of moles of gas in Y is three times the number of moles of the gas in X. The pressure of the gas in X is  $P_X$  and the pressure of the gas in Y is  $P_Y$ .

What is the ratio  $\frac{P_X}{P_Y}$ ?

- A.  $\frac{1}{6}$
- B.  $\frac{2}{3}$
- C.  $\frac{3}{2}$
- D. 6

12. Which process will increase the entropy of the local surroundings?

- A. The melting of a block of ice
- B. Evaporation of water vapour
- C. The isothermal expansion of a gas
- D. The adiabatic expansion of a gas

13. A particle P executes simple harmonic motion (SHM) about its equilibrium position Y.



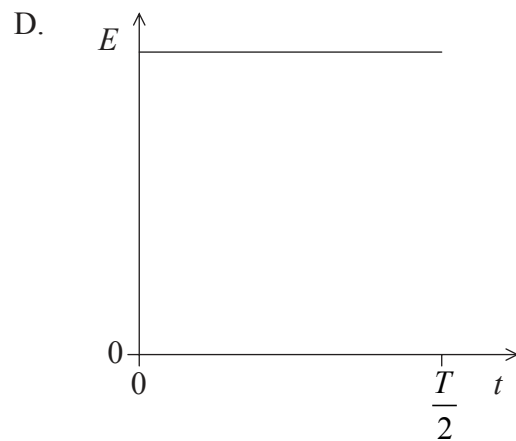
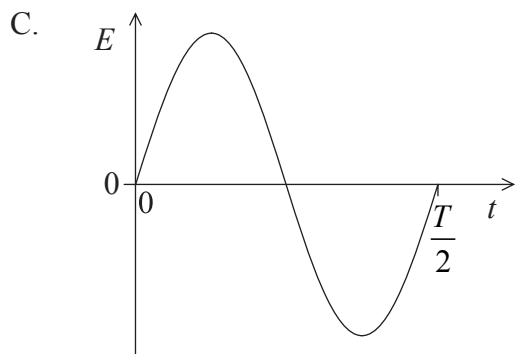
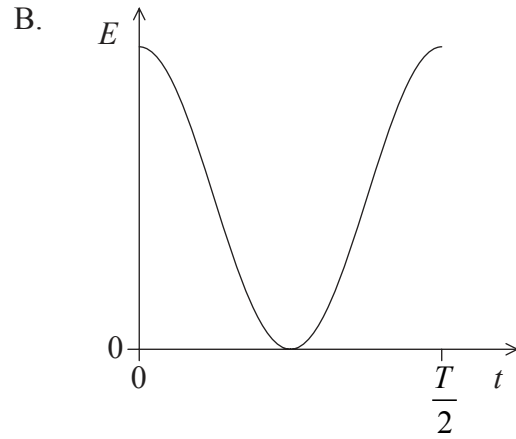
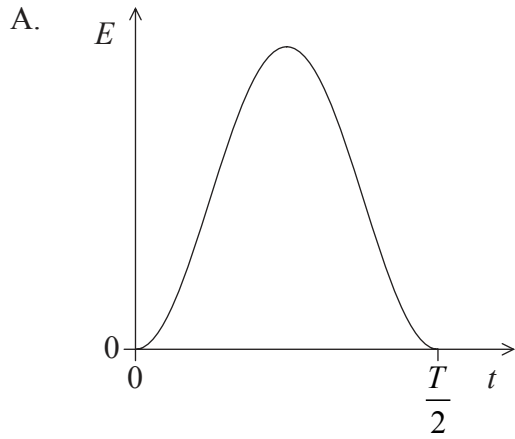
The amplitude of the motion is XY.

At which of the positions shown on the diagram is the acceleration of P equal to zero and the kinetic energy of P equal to zero?

	<b>Acceleration</b>	<b>Kinetic energy</b>
A.	Y	X
B.	X	X
C.	Y	Y
D.	X	Y

14. A particle executes simple harmonic motion (SHM) with period  $T$ .

Which sketch graph correctly shows how the total energy  $E$  of the particle varies with time  $t$  from  $t=0$  to  $t=\frac{T}{2}$ ?





15. A wave travels from a medium X of refractive index  $n_x$  into a medium Y of refractive index  $n_y$ .

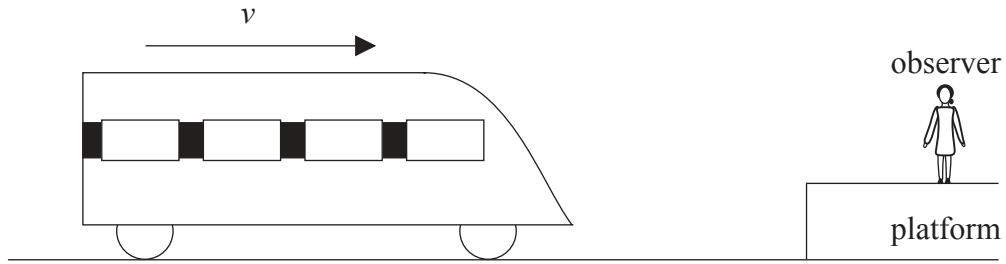
Which of the following correctly identifies the ratio  $\frac{\text{speed of wave in X}}{\text{speed of wave in Y}}$  and the ratio  $\frac{\text{wavelength of the wave in X}}{\text{wavelength of the wave in Y}}$ ?

	$\frac{\text{speed of wave in X}}{\text{speed of wave in Y}}$	$\frac{\text{wavelength of the wave in X}}{\text{wavelength of the wave in Y}}$
A.	$\frac{n_y}{n_x}$	$\frac{n_x}{n_y}$
B.	$\frac{n_y}{n_x}$	$\frac{n_y}{n_x}$
C.	$\frac{n_x}{n_y}$	$\frac{n_x}{n_y}$
D.	$\frac{n_x}{n_y}$	$\frac{n_y}{n_x}$

16. The lowest frequency emitted by an organ pipe that is open at both ends is  $f$ . What is the lowest frequency emitted by an organ pipe of the same length that is closed at one end?

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

17. The diagram shows a train travelling in a straight line at constant speed  $v$ , as it approaches the platform of a station.

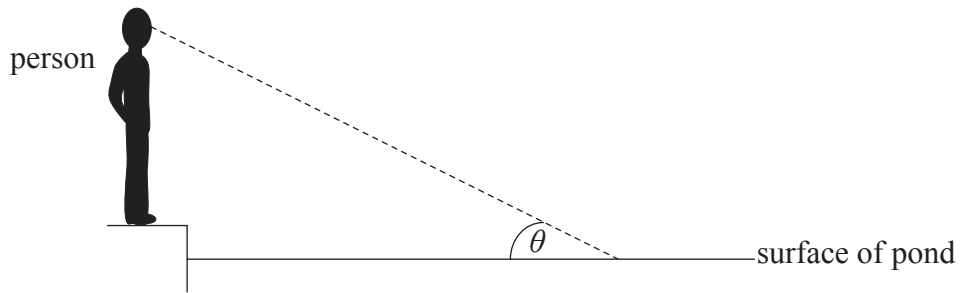


The whistle of the engine is emitting a sound of constant frequency. Which of the following is **not** true for the sound of the whistle heard by an observer on the platform?

- A. A sudden change in frequency of the sound as the train passes the observer.
  - B. A sound of constant frequency as the train approaches the observer.
  - C. A sound of increasing frequency as the train approaches the observer and of decreasing frequency after the train has passed the observer.
  - D. A sound of constant frequency after the train has passed the observer.
18. A parallel beam of coherent light of wavelength  $\lambda$  is incident on a rectangular slit of width  $d$ . After passing through the slit the light is incident on a screen a distance  $D$  from the slit where  $D$  is much greater than  $d$ . What is the width of the central maximum of the diffraction pattern as measured on the screen?

- A.  $\frac{2D\lambda}{d}$
- B.  $\frac{2d}{D\lambda}$
- C.  $\frac{D\lambda}{d}$
- D.  $\frac{d}{D\lambda}$

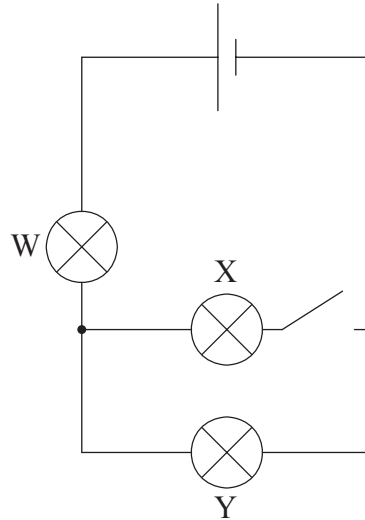
19. A person wearing polarizing sunglasses stands at the edge of a pond in bright sunlight.



The surface of the pond is flat and the line of sight of the person makes an angle  $\theta$  with the surface. The refractive index of the pond water is  $n$ . What is the value of  $\theta$  for which the intensity of the sunlight reflected by the surface to the person's eye is a minimum?

- A.  $\tan^{-1}(n)$
- B.  $\cos^{-1}\left(\frac{1}{n}\right)$
- C.  $\cos^{-1}(n)$
- D.  $\tan^{-1}\left(\frac{1}{n}\right)$
20. Which of the following is a statement of Ohm's law?
- A. The resistance of a conductor is constant.
- B. The current in a conductor is inversely proportional to the potential difference across the conductor provided the temperature is constant.
- C. The resistance of a conductor is constant provided that the temperature is constant.
- D. The current in a conductor is proportional to the potential difference across it.

21. Three identical filament lamps W, X and Y are connected in the circuit as shown. The cell has negligible internal resistance.

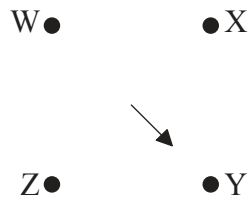


When the switch is closed, all the lamps light. Which of the following correctly describes what happens to the brightness of lamp W and lamp Y when the switch is opened?

	Lamp W	Lamp Y
A.	decreases	decreases
B.	increases	decreases
C.	decreases	increases
D.	increases	increases

22. The gravitational field strength at a point X in a gravitational field is defined as the force
- A. per unit mass on a mass placed at X.
  - B. on a mass placed at X.
  - C. per unit mass on a small point mass placed at X.
  - D. on a small point mass placed at X.

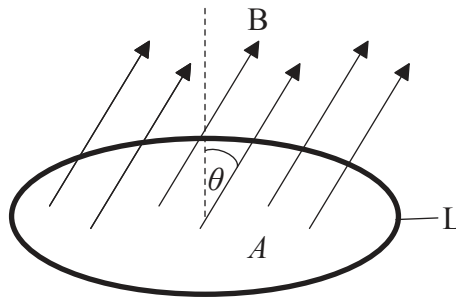
23. Four point charges of equal magnitude W, X, Y and Z are each fixed to a corner of a square.



W is a positive charge and X is a negative charge. The arrow shows the direction of the resultant electric field at the centre of the square. What are the correct signs of charge Y and of charge Z?

	Y	Z
A.	positive	positive
B.	negative	positive
C.	positive	negative
D.	negative	negative

24. The diagram shows a loop L of wire in a uniform magnetic field B.



The loop encloses an area  $A$  and the field is directed at an angle  $\theta$  to the normal to the plane of the loop. The strength of  $B$  is increasing at a uniform rate  $R$ . What is the emf induced in  $L$ ?

- A.  $\frac{RA}{\cos \theta}$
- B.  $RA \cos \theta$
- C.  $\frac{RA}{\sin \theta}$
- D.  $RA \sin \theta$
25. The voltage output of a particular power station is stepped up by a factor of  $10^3$ . As a result the power loss in the transmission cables is reduced by a factor of
- A.  $10^3$ .
- B.  $10^6$ .
- C.  $10^9$ .
- D.  $10^{12}$ .

26. Which of the following provides evidence for the existence of atomic energy levels?
- A. Absorption spectra
  - B. Nuclear fission
  - C. The Geiger–Marsden experiment
  - D. Radioactive decay
27. What is the definition of the unified atomic mass unit?
- A. The mass of one atom of hydrogen.
  - B.  $\frac{1}{12}$  of the mass of an atom of carbon-12.
  - C. The mass of one atom of carbon-12.
  - D.  $\frac{1}{16}$  of the mass of an atom of oxygen-16.
28. Light that is shone onto a metal surface may result in the emission of electrons from the surface. Three statements regarding the emission of the electrons are the
- I. number of electrons emitted per unit time depends on the intensity of the incident light
  - II. energy of the electrons depends on the frequency of the incident light
  - III. emission of the electrons takes place instantaneously.

Which of the above statements can **only** be explained by assuming light consists of photons?

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

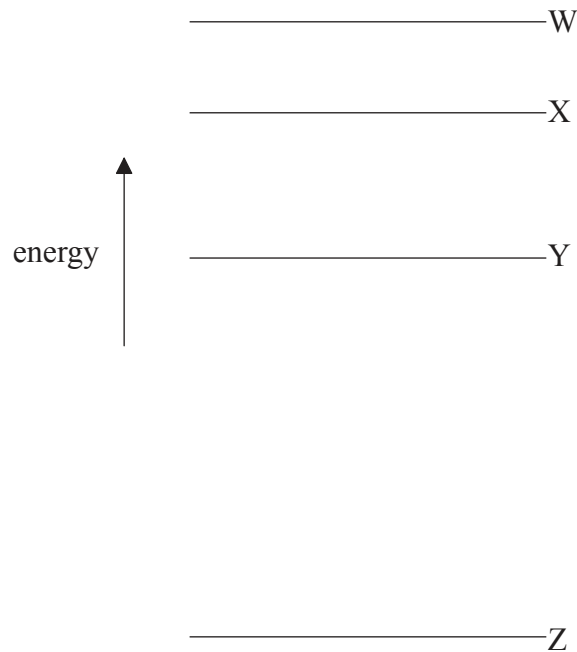
29. An electron X is accelerated from rest through a potential difference  $V$ . Another electron Y is accelerated from rest through a potential difference  $2V$ . After acceleration, the de Broglie wavelength of X is  $\lambda_X$  and that of Y is  $\lambda_Y$ . The speeds reached by the electrons are well below that of the speed of light.

What is the ratio  $\frac{\lambda_X}{\lambda_Y}$ ?

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



30. The diagram shows four energy levels W, X, Y and Z of an atom.



Which electron transition will produce a photon of the longest wavelength and which transition will produce a photon with the highest frequency?

	<b>Longest wavelength</b>	<b>Highest frequency</b>
A.	W → X	W → Z
B.	W → Z	W → Z
C.	W → X	W → X
D.	W → Z	W → X

31. If there is no uncertainty in the value of the de Broglie wavelength of a particle then this means that

- A. both the momentum and position of the particle are known precisely.
- B. the position of the particle is known precisely but all knowledge of its momentum is lost.
- C. both the energy and the position of the particle are known precisely.
- D. only the momentum of the particle is known precisely but all knowledge of its position is lost.

32. The nuclei in a sample of a radioactive isotope decay by emitting  $\alpha$  and  $\gamma$  particles. Which of the following is correct for the energies of the  $\alpha$  particles and for the energies of the  $\gamma$  particles?

	<b><math>\alpha</math> particle energies</b>	<b><math>\gamma</math> particle energies</b>
A.	discrete	discrete
B.	continuous	discrete
C.	discrete	continuous
D.	continuous	continuous

33. A pure sample of a known element has a very long half-life. What measurement(s), together with the initial activity of the sample, must be made in order to measure the half-life of the element?

- A. The activity of the sample after a given period of time.
- B. The mass of the sample after a given period of time.
- C. The activity and the mass of the sample after a given period of time.
- D. The mass of the sample.

34. Degraded energy is energy that is

- A. produced by the combustion of fossil fuels.
- B. no longer available to perform useful work.
- C. produced by low-energy density fuels.
- D. relatively cheap to produce.

35. A black body has absolute temperature  $T$  and surface area  $A$ . The intensity of the radiation emitted by the body is  $I$ . Another black body of surface area  $2A$  has absolute temperature  $2T$ . What is the intensity of radiation emitted by this second black body?
- A.  $4I$
  - B.  $8I$
  - C.  $16I$
  - D.  $32I$
36. In the production of energy from nuclear fission, fuel enrichment means increasing, in the fuel rods, the amount of
- A. uranium-238.
  - B. plutonium-239.
  - C. uranium-235.
  - D. uranium-235 and plutonium-239.
37. The greenhouse effect can be explained by the fact that the infrared radiation emitted by the surface of Earth
- A. is absorbed by the atmosphere and then re-radiated in all directions.
  - B. raises the temperature of the upper atmosphere.
  - C. is trapped by the upper atmosphere.
  - D. is absorbed by the atmosphere and then all of it is re-radiated back to the surface of Earth.

38. What is the decimal equivalent and most-significant bit (MSB) of the binary number 10010?

	<b>Decimal equivalent</b>	<b>MSB</b>
A.	36	0
B.	18	0
C.	36	1
D.	18	1

39. The capacitance of a pixel of a particular charge-coupled device (CCD) is 1.6pF. When the CCD is illuminated for a short period of time the potential difference across the pixel is raised from zero to 1.0mV. How many electrons are ejected from the pixel in this interval of time?

- A.  $10^{13}$
- B.  $10^{10}$
- C.  $10^7$
- D.  $10^4$

40. Which phenomenon is associated with the reading of information stored on a CD?

- A. Diffraction
- B. Refraction
- C. Interference
- D. Polarization