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**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Wednesday 11 May 2011 (afternoon)

1 hour

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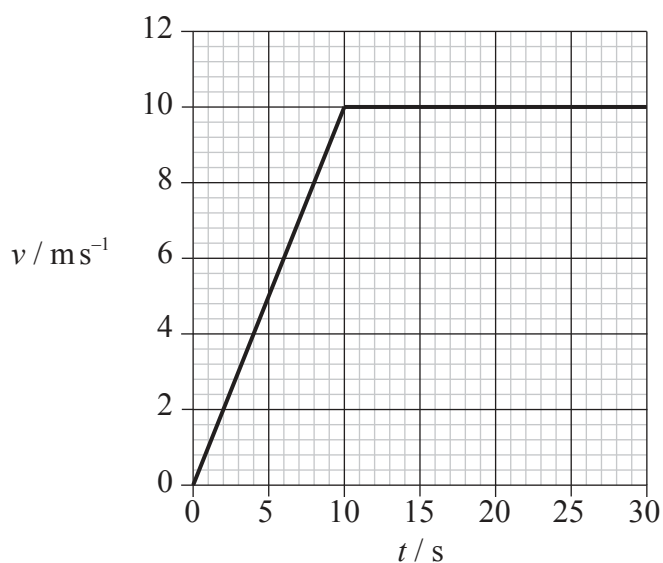
**INSTRUCTIONS TO CANDIDATES**

- 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.

1. The current  $I$  through a resistor is measured with a digital ammeter to be  $0.10\text{ A}$ . The uncertainty in the calculated value of  $I^2$  will be

- A. 1%.
- B. 2%.
- C. 5%.
- D. 20%.

2. Joseph runs along a long straight track. The variation of his speed  $v$  with time  $t$  is shown below.



After 25 seconds Joseph has run 200 m. Which of the following is correct at 25 seconds?

	Instantaneous speed / $\text{m s}^{-1}$	Average speed / $\text{m s}^{-1}$
A.	$8\text{ m s}^{-1}$	$8\text{ m s}^{-1}$
B.	$8\text{ m s}^{-1}$	$10\text{ m s}^{-1}$
C.	$10\text{ m s}^{-1}$	$8\text{ m s}^{-1}$
D.	$10\text{ m s}^{-1}$	$10\text{ m s}^{-1}$

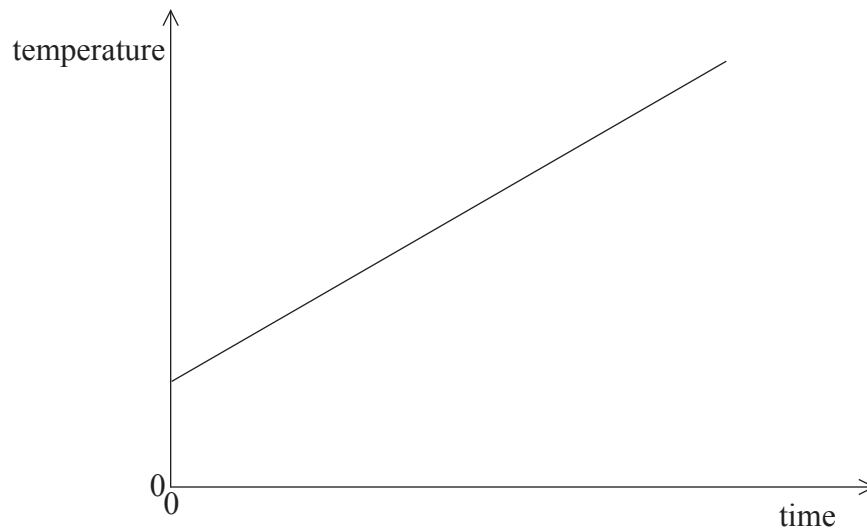
3. A skydiver of mass 80 kg falls vertically with a constant speed of  $50 \text{ ms}^{-1}$ . The upward force acting on the skydiver is approximately
- A. 0 N.
  - B. 80 N.
  - C. 800 N.
  - D. 4000 N.
4. A particle of mass  $m$  is moving with constant speed  $v$  in uniform circular motion. What is the total work done by the centripetal force during one revolution?
- A. Zero
  - B.  $\frac{mv^2}{2}$
  - C.  $mv^2$
  - D.  $2\pi mv^2$
5. A cyclist rides around a circular track at a uniform speed. Which of the following correctly gives the net horizontal force on the cyclist at any given instant of time?

	Net horizontal force along direction of motion	Net horizontal force normal to direction of motion
A.	zero	zero
B.	zero	non zero
C.	non zero	zero
D.	non zero	non zero

6. A solid piece of tungsten melts into liquid without a change in temperature. Which of the following is correct for the molecules in the liquid phase compared with the molecules in the solid phase?

	<b>Kinetic energy</b>	<b>Potential energy</b>
A.	same	greater
B.	same	same
C.	greater	greater
D.	greater	same

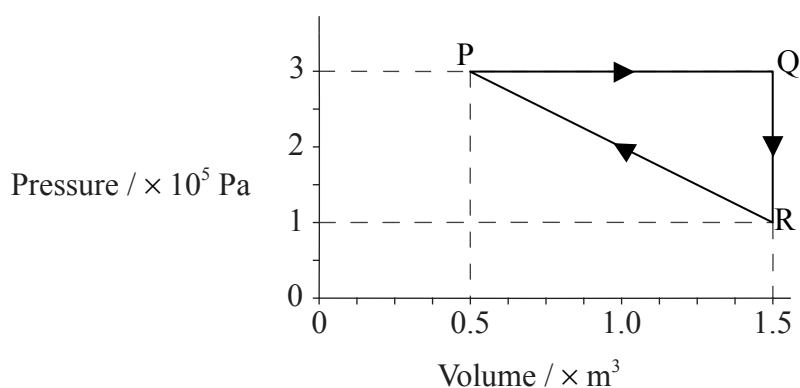
7. A heater of constant power heats a liquid of mass  $m$  and specific heat capacity  $c$ . The graph below shows how the temperature of the liquid varies with time.



The gradient of the graph is  $k$  and no energy is lost to the surroundings. What is the power of the heater?

- A.  $kmc$
- B.  $\frac{k}{mc}$
- C.  $\frac{mc}{k}$
- D.  $\frac{1}{kmc}$

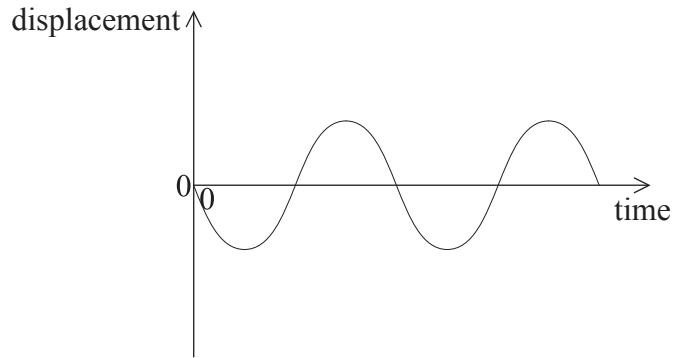
8. Which of the following is equivalent to the principle of energy conservation?
- A. Newton’s first law
  - B. The first law of thermodynamics
  - C. Newton’s second law
  - D. The second law of thermodynamics
9. An ideal gas undergoes the thermodynamic changes represented in the  $P$ – $V$  diagram below ( $P \rightarrow Q \rightarrow R \rightarrow P$ ).



Which of the following is the net work done by the gas in a cycle?

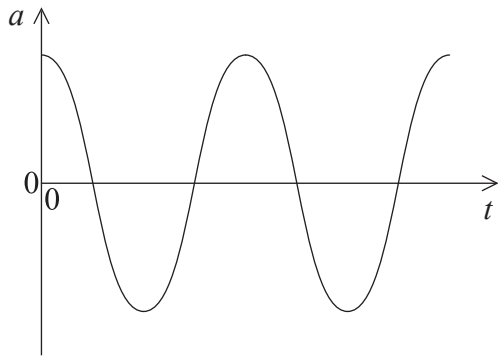
- A.  $4.5 \times 10^5 \text{ J}$
- B.  $3.0 \times 10^5 \text{ J}$
- C.  $1.0 \times 10^5 \text{ J}$
- D. Zero

10. The graph shows how the displacement varies with time for an object undergoing simple harmonic motion.

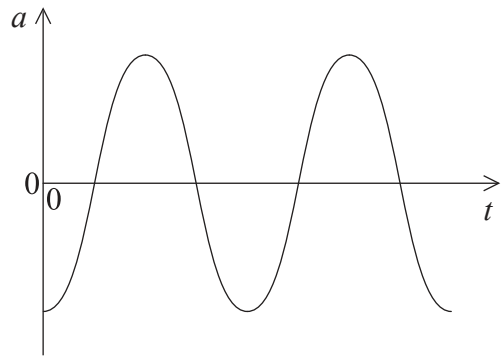


Which graph shows how the object's acceleration  $a$  varies with time  $t$ ?

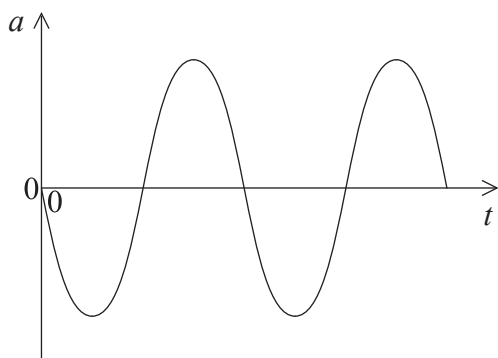
A.



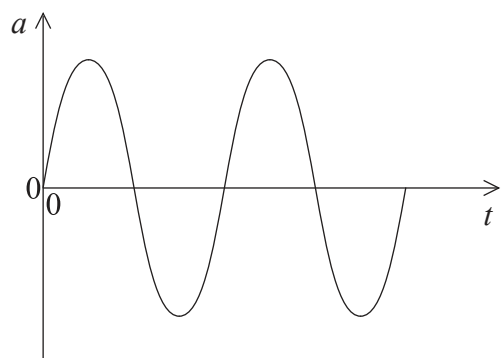
B.



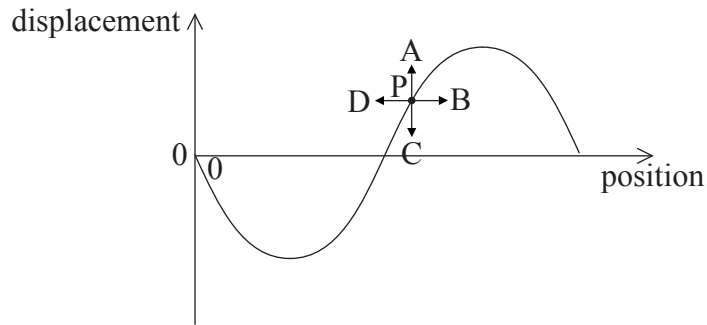
C.



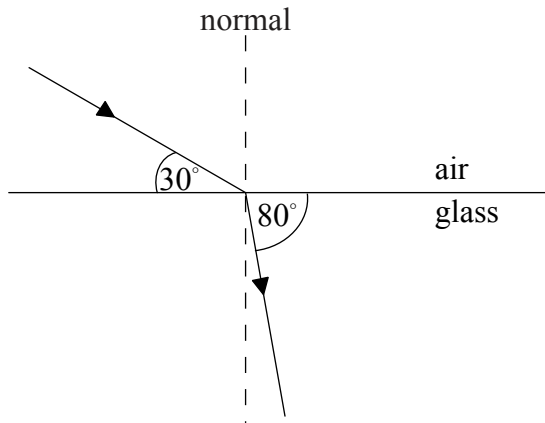
D.



11. A transverse wave travels from left to right. The graph below shows how, at a particular instant of time, the displacement of particles in the medium varies with position. Which arrow represents the direction of the velocity of the particle marked P?



12. Light travels from air into glass as shown below.



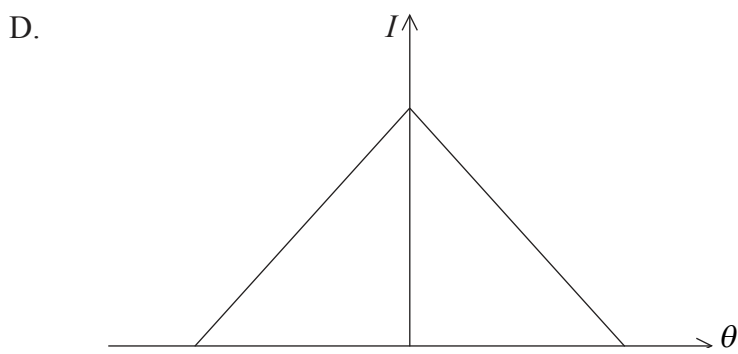
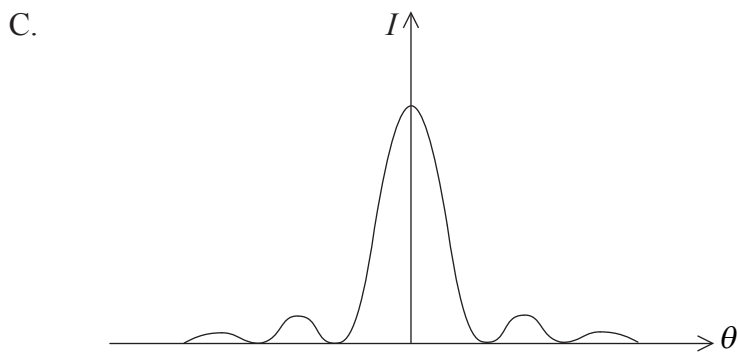
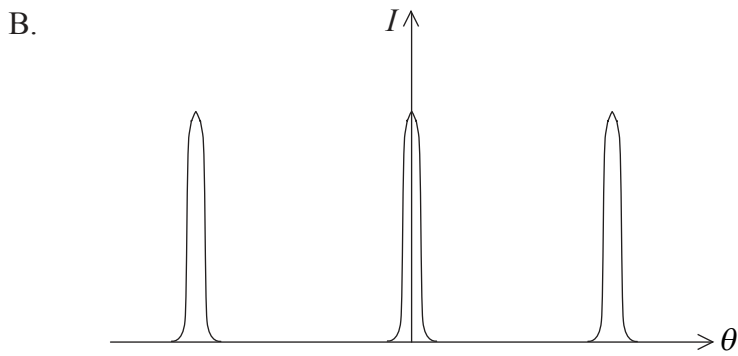
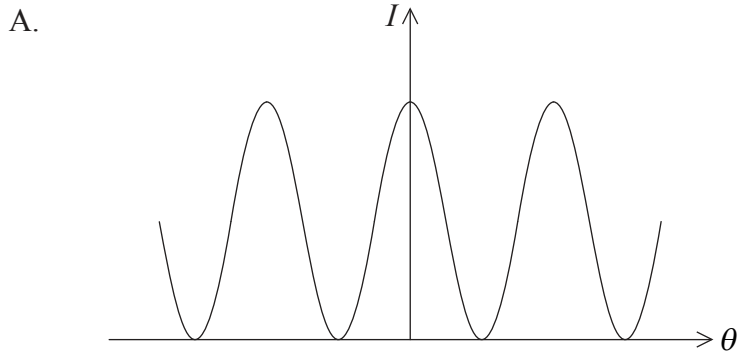
The refractive index of the glass is

- A.  $\frac{\sin 30^\circ}{\sin 80^\circ}$
- B.  $\frac{\sin 80^\circ}{\sin 30^\circ}$
- C.  $\frac{\sin 60^\circ}{\sin 10^\circ}$
- D.  $\frac{\sin 10^\circ}{\sin 60^\circ}$

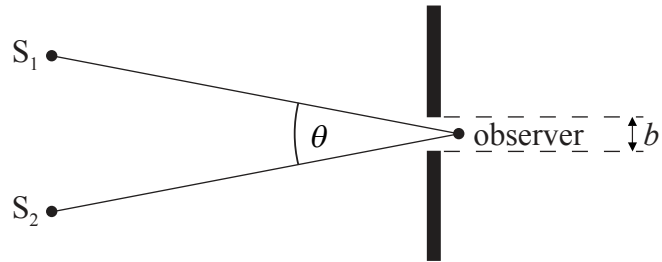
13. The fundamental (first harmonic) frequency for a particular organ pipe is 330 Hz. The pipe is closed at one end but open at the other. What is the frequency of its next highest harmonic?
- A. 110 Hz
  - B. 165 Hz
  - C. 660 Hz
  - D. 990 Hz



14. Light is diffracted at a single slit. Which of the following graphs best represents how the intensity  $I$  of the diffracted light varies with the diffraction angle  $\theta$ ?



15. Light of wavelength  $\lambda$  is emitted by two point sources. The light passes through a circular aperture of diameter  $b$  and is received by an observer. The angular separation of the sources from the observer's position is  $\theta$ . The sources are **not** resolved by the observer. Which of the following mathematical relationships applies?



- A.  $\theta < 1.22 \frac{\lambda}{b}$
- B.  $\theta > 1.22 \frac{\lambda}{b}$
- C.  $\theta = 1.22 \frac{\lambda}{b}$
- D.  $\theta = \frac{\lambda}{b}$

16. Plane-polarized light is incident normally on a polarizer which is able to rotate in the plane perpendicular to the light as shown below.

Diagram 1

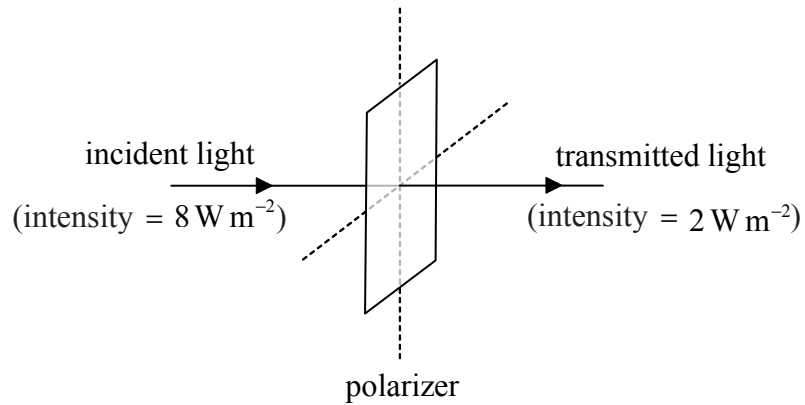
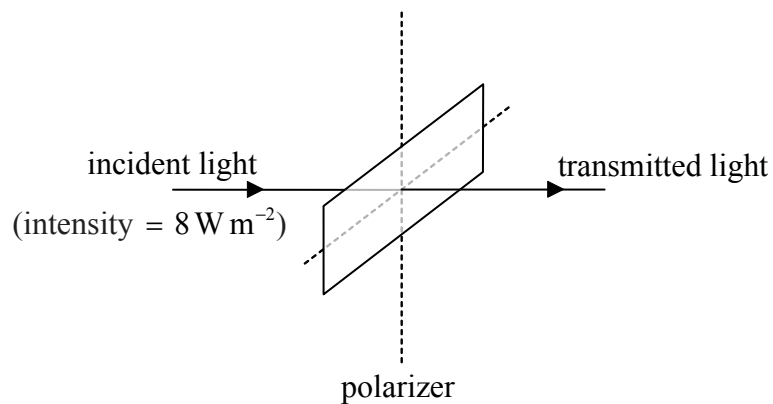


Diagram 2



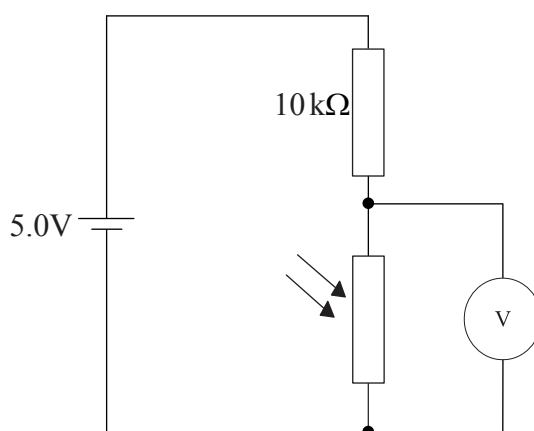
In diagram 1, the intensity of the incident light is  $8 \text{ W m}^{-2}$  and the transmitted intensity of light is  $2 \text{ W m}^{-2}$ . Diagram 2 shows the polarizer rotated  $90^\circ$  from the orientation in diagram 1. What is the new transmitted intensity?

- A.  $0 \text{ W m}^{-2}$
- B.  $2 \text{ W m}^{-2}$
- C.  $6 \text{ W m}^{-2}$
- D.  $8 \text{ W m}^{-2}$

17. One electronvolt is equal to

- A.  $1.6 \times 10^{-19} \text{ C}$ .
- B.  $1.6 \times 10^{-19} \text{ J}$ .
- C.  $1.6 \times 10^{-19} \text{ V}$ .
- D.  $1.6 \times 10^{-19} \text{ W}$ .

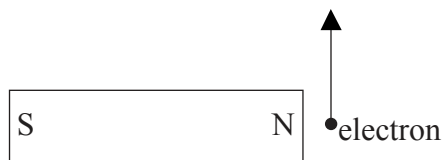
18. A light-dependent resistor (LDR) and a fixed resistor are connected in the potential divider circuit shown below.



The voltmeter reads 3.0 V. Which of the following changes would cause the reading on the voltmeter to increase?

- A. Swapping the positions of the LDR and the fixed resistor
- B. Increasing the resistance of the fixed resistor
- C. Increasing the amount of light shining on the LDR
- D. Decreasing the amount of light shining on the LDR

19. A coil of wire has a large number of turns. It is moved relative to a fixed magnetic field. The emf generated will be equal to the
- A. rate of change of magnetic flux linkage.
  - B. rate of change of the magnetic flux through the coil.
  - C. change of magnetic flux linkage.
  - D. change of the magnetic flux through the coil.
20. A sinusoidal ac power supply has rms voltage  $V$  and supplies rms current  $I$ . What is the maximum instantaneous power delivered?
- A.  $2VI$
  - B.  $\sqrt{2}VI$
  - C.  $VI$
  - D.  $\frac{VI}{2}$
21. An electron passes the north pole of a bar magnet as shown below.



What is the direction of the magnetic force on the electron?

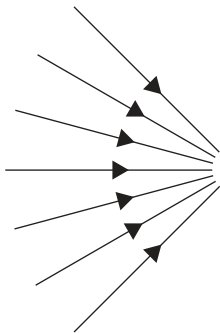
- A. Into the page
- B. Out of the page
- C. To the left
- D. To the right

22. A positively charged particle follows a circular path as shown below.

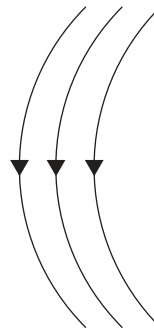


Which of the following electric fields could have caused the charged particle to follow the above path?

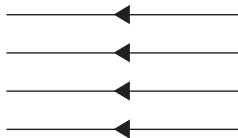
A.



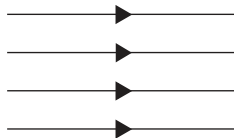
B.



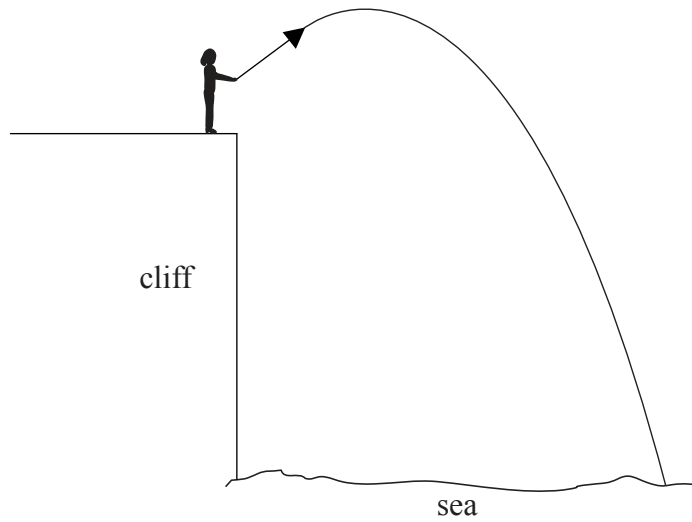
C.



D.



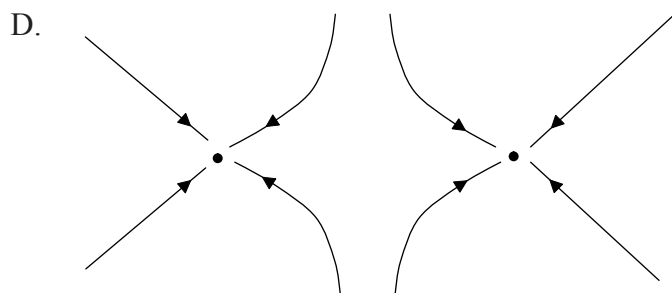
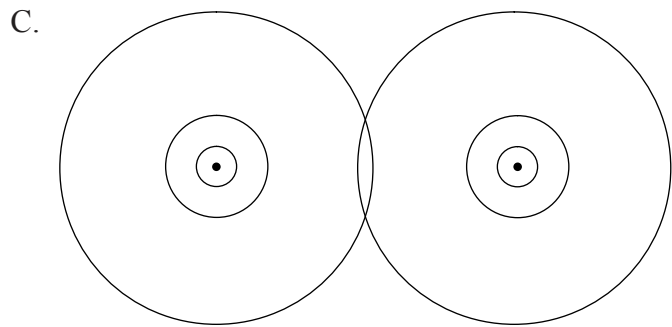
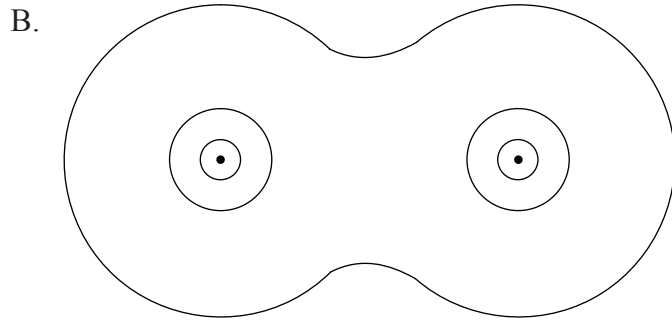
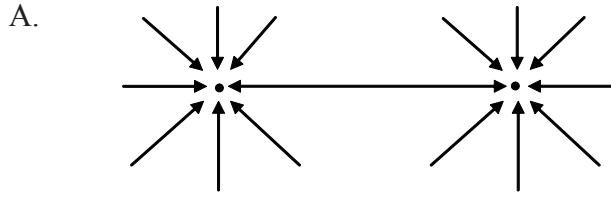
23. A stone is thrown from a cliff and it lands in the sea as shown below. Air resistance is negligible.



Which of the following statements is correct whilst the stone is in motion?

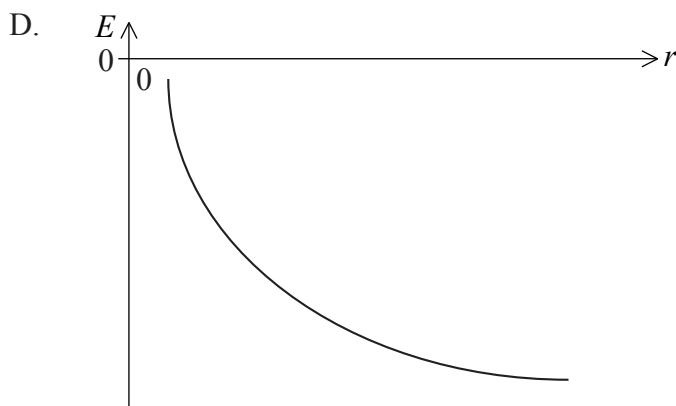
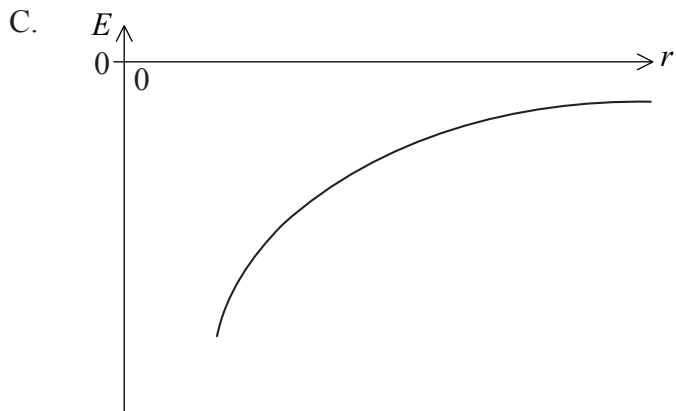
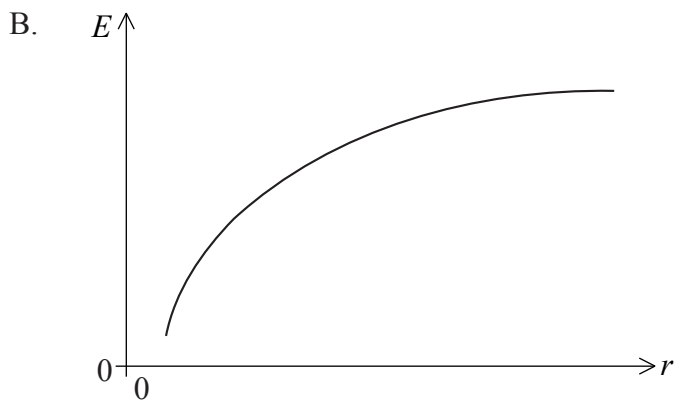
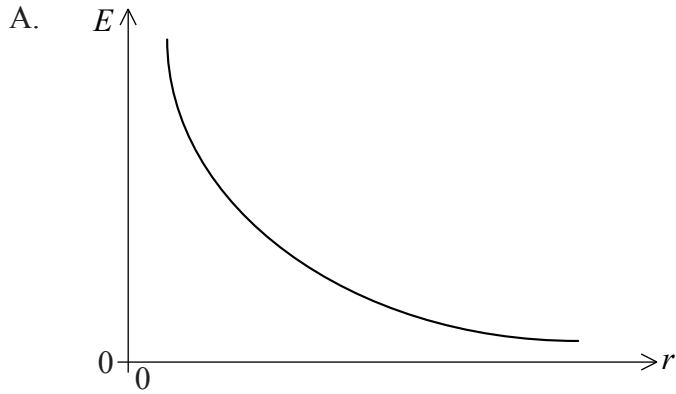
- A. The vertical component of the stone's displacement is constant.
- B. The horizontal component of the stone's displacement is constant.
- C. The vertical component of the stone's velocity is constant.
- D. The horizontal component of the stone's velocity is constant.

24. Which of the diagrams below best represents the equipotential surfaces around two identical point masses?





25. Which of the following graphs represents how the total energy  $E$  of an orbiting satellite varies with orbital radius  $r$ ?

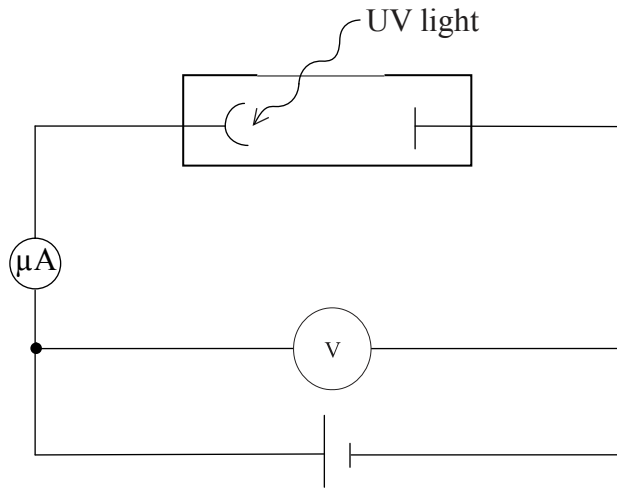


26. Which of the following gives the correct number of protons and neutrons in a nucleus of carbon-14 ( ${}^{14}_6\text{C}$ ).

	<b>Protons</b>	<b>Neutrons</b>
A.	8	6
B.	6	8
C.	14	6
D.	6	14

27. Which of the following causes the greatest number of ionizations as it passes through 1 cm of air? (The total energy of the ionizing radiation is the same.)
- A. An alpha particle
  - B. A beta particle
  - C. A gamma-ray
  - D. An X-ray

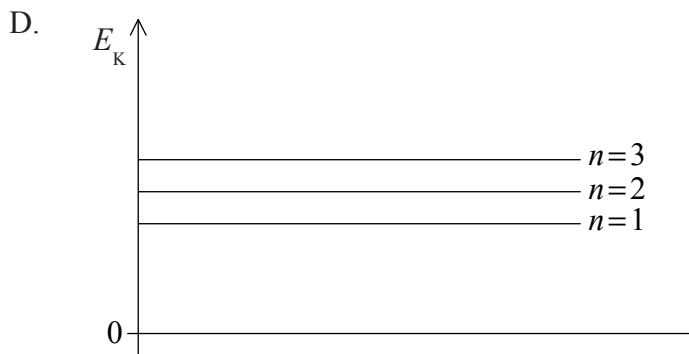
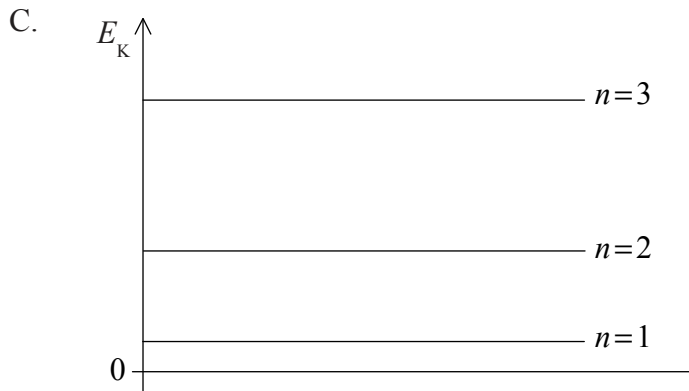
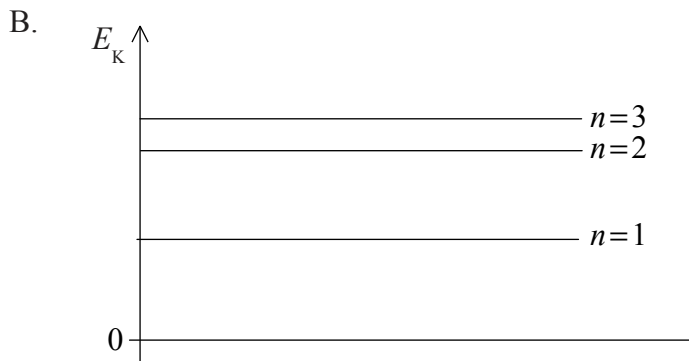
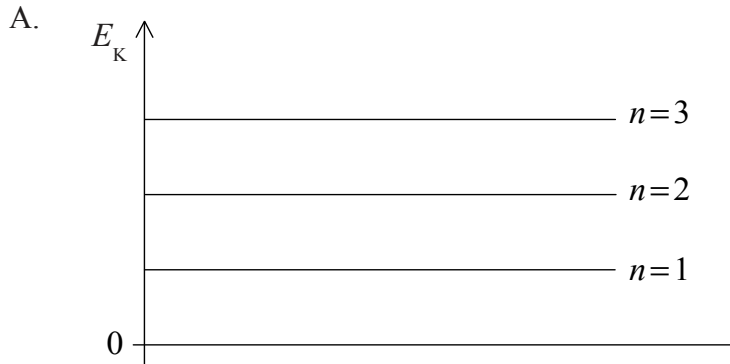
28. The diagram below shows a circuit involving a photoelectric cell. When UV light is shone onto the metal cathode, electrons are emitted establishing a photocurrent.



Which of the following changes could cause the photocurrent to stop?

- A. Increasing the potential difference of the power supply.
  - B. Increasing the frequency of the UV light.
  - C. Increasing the intensity of the UV light.
  - D. Changing the metal surface to one with a smaller work function.
29. Electrons are accelerated from rest through a potential difference  $V$ . Their de Broglie wavelength is  $\lambda$ . The accelerating potential difference is increased to  $2V$ . Which of the following gives the new de Broglie wavelength?
- A.  $2\lambda$
  - B.  $\sqrt{2}\lambda$
  - C.  $\frac{\lambda}{\sqrt{2}}$
  - D.  $\frac{\lambda}{2}$

30. Which of the following energy level diagrams best represents the kinetic energy  $E_k$  of the “electron in a box” model, where an electron is confined to move in one dimension? The variable  $n$  is an integer (1, 2, 3, 4 etc.).



31. A proton is confined within a nucleus. What is the order of magnitude of the uncertainty in its momentum?
- A.  $10^{-30}$  Ns
  - B.  $10^{-20}$  Ns
  - C.  $10^{-10}$  Ns
  - D. 1 Ns
32. Different nuclides spontaneously undergo radioactive decay, emitting either  $\alpha$ ,  $\beta$  or  $\gamma$  radiation. Which of the following correctly identifies all the emissions that **do not** have discrete energies?
- A.  $\alpha$
  - B.  $\beta$
  - C.  $\gamma$
  - D.  $\alpha$  and  $\gamma$
33. The half-life of a radioactive isotope is 10 days. What is the percentage of the sample remaining after 25 days?
- A. 0%
  - B. 18%
  - C. 25%
  - D. 40%

34. The design of a nuclear power station includes an electrical generator. The function of the generator is to convert
- A. nuclear energy to kinetic energy.
  - B. kinetic energy to thermal energy.
  - C. thermal energy to electrical energy.
  - D. kinetic energy to electrical energy.
35. A wind turbine produces a power  $P$  when the wind speed is  $v$ . Assuming that the efficiency of the turbine is constant, the best estimate for the power produced when the wind speed becomes  $2v$  is
- A.  $2P$ .
  - B.  $4P$ .
  - C.  $6P$ .
  - D.  $8P$ .
36. What is the phenomenon that best explains why greenhouse gases absorb infrared radiation?
- A. Resonance
  - B. Interference
  - C. Refraction
  - D. Diffraction
37. Which of the following fuels has the highest energy density?
- A. Coal
  - B. Gas
  - C. Oil
  - D. Uranium

38. The decimal number 18 is represented in binary by a five bit digital number. Which of the following correctly identifies the least-significant bit (LSB) and the most-significant bit (MSB) of the binary number?

	LSB	MSB
A.	0	0
B.	0	1
C.	1	0
D.	1	1

39. A CD stores digital information with a series of bumps (lands) and pits. The depth of each pit is  $d$ . Which of the following is the most appropriate wavelength of laser light to recover the information?

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

40. Which of the following digital devices is least likely to use a charge-coupled device (CCD) in its construction?

- A. Fax machine
- B. Camera
- C. Watch
- D. X-ray machine