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**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Wednesday 11 May 2011 (afternoon)

1 hour

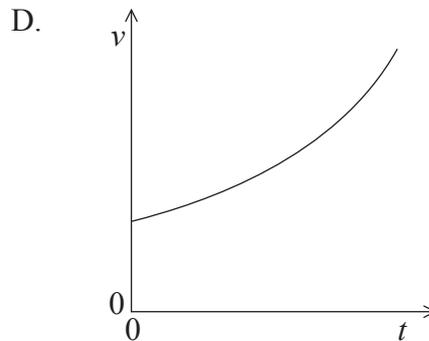
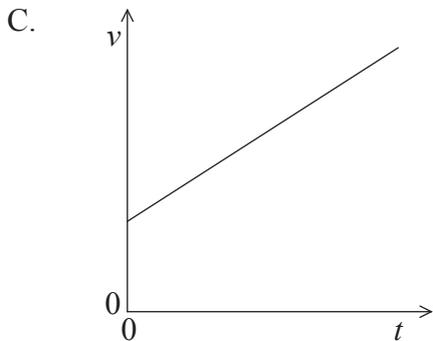
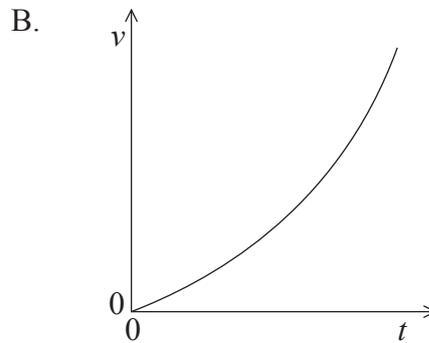
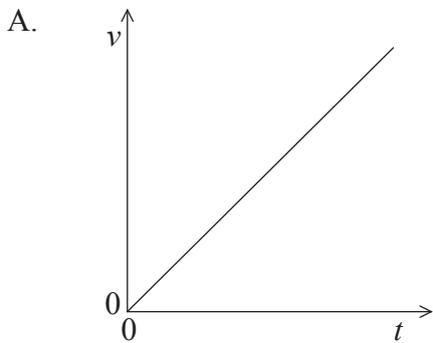
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**INSTRUCTIONS TO CANDIDATES**

- 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. A body accelerates from rest with a uniform acceleration  $a$  for a time  $t$ . The uncertainty in  $a$  is 8% and the uncertainty in  $t$  is 4%. The uncertainty in the speed is
- A. 32%.
  - B. 12%.
  - C. 8%.
  - D. 2%.

2. A car accelerates from rest. The acceleration increases with time. Which graph shows the variation with time  $t$  of the speed  $v$  of the car?

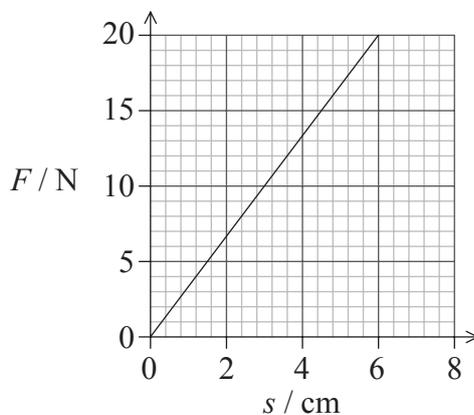


3. Which of the following is the condition for a body to be in translational equilibrium?
- A. The resultant force on the body in any direction is zero.
  - B. The velocity of the body in any direction is zero.
  - C. No external force is acting on the body.
  - D. No work is done on the body.

4. A body is moving in a straight line. A force  $F$  acts on the body in the direction of the body's motion. A resistive force  $f$  acts on the body. Both forces act along the same straight line as the motion of the body. The rate of change of momentum of the body is equal to

- A.  $F - f$ .
- B.  $F$ .
- C.  $F + f$ .
- D.  $f$ .

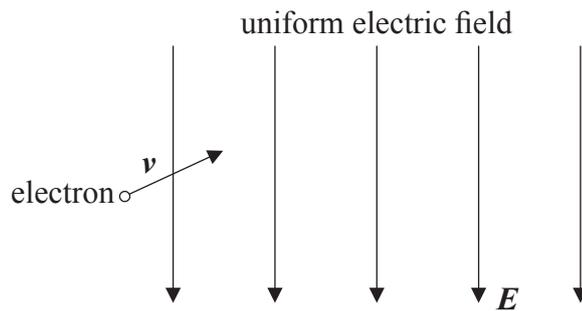
5. The graph shows the variation with force  $F$  of the extension  $s$  of a spring.



The work done in changing the extension of the spring from 3.0 cm to 6.0 cm is

- A. 15 Ncm.
- B. 30 Ncm.
- C. 45 Ncm.
- D. 60 Ncm.

6. The diagram below shows a uniform electric field of strength  $E$ . The field is in a vacuum.



An electron enters the field with a velocity  $v$  in the direction shown. The electron is moving in the plane of the paper. The path followed by the electron will be

- A. parabolic.
  - B. in the direction of  $E$ .
  - C. in the direction of  $v$ .
  - D. circular.
7. A spacecraft moves from point X to point Y in the gravitational field of Earth. At point X, the gravitational potential is  $-14 \text{ MJ kg}^{-1}$ . At point Y, the gravitational potential is  $-2 \text{ MJ kg}^{-1}$ . Which of the following describes the direction of the motion of the spacecraft relative to Earth and the change in gravitational potential?

	<b>Direction of Motion</b>	<b>Change in gravitational potential</b>
A.	towards Earth	$+12 \text{ MJ kg}^{-1}$
B.	towards Earth	$-12 \text{ MJ kg}^{-1}$
C.	away from Earth	$+12 \text{ MJ kg}^{-1}$
D.	away from Earth	$-12 \text{ MJ kg}^{-1}$

8. A spacecraft is in orbit at a distance  $r$  from the centre of the Earth. The engine of the spacecraft is fired and it moves to a new orbit of radius  $2r$ . Which of the following describes the variations in kinetic energy and total energy of the spacecraft?

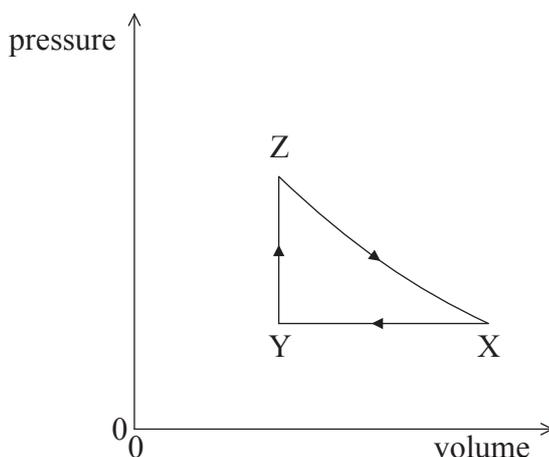
	<b>Kinetic energy</b>	<b>Total energy</b>
A.	decrease	increase
B.	decrease	decrease
C.	increase	increase
D.	increase	decrease

9. The energy of the molecules of an ideal gas is
- A. thermal only.
  - B. thermal and potential.
  - C. potential and kinetic.
  - D. kinetic only.
10. The volume of an ideal gas in a container is increased at constant temperature. Which of the following statements is/are correct about the molecules of the gas?
- I. Their average speed remains constant.
  - II. The frequency of collisions of molecules with unit area of the container wall decreases.
  - III. The force between them decreases.
- A. I only
  - B. I and II only
  - C. I and III only
  - D. II and III only

11. During an adiabatic expansion, a gas does 50J of work against the surroundings. It is then cooled at constant volume by removing 20J of energy from the gas. The magnitude of the total change in internal energy of the gas is

- A. 70J.
- B. 50J.
- C. 30J.
- D. 20J.

12. The diagram shows the pressure volume relationship for a fixed mass of an ideal gas that undergoes a cycle XYZ.

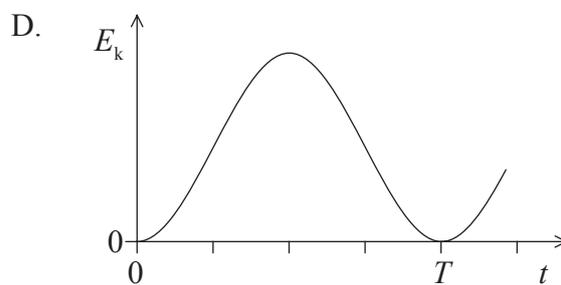
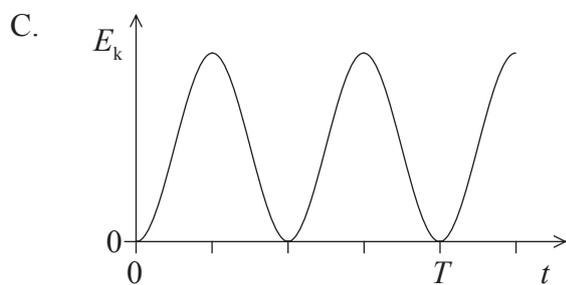
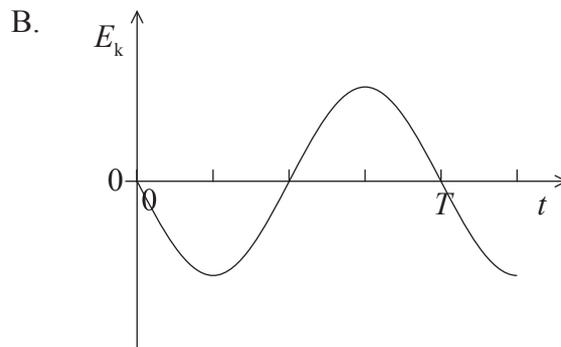
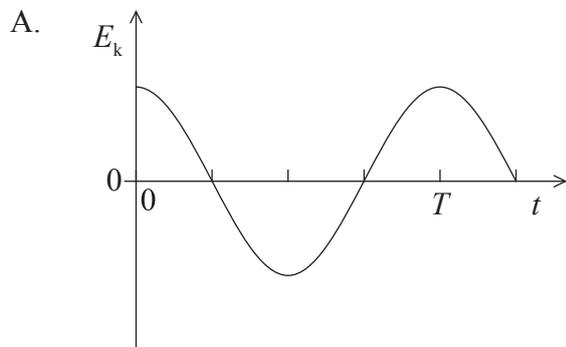


In which part(s) of the cycle is external work done **on** the gas?

- A.  $Y \rightarrow Z$  only
- B.  $Y \rightarrow Z$  and  $Z \rightarrow X$  only
- C.  $X \rightarrow Y$  and  $Z \rightarrow X$  only
- D.  $X \rightarrow Y$  only

13. A particle oscillates with simple harmonic motion with period  $T$ .

At time  $t=0$ , the particle has its maximum displacement. Which graph shows the variation with time  $t$  of the kinetic energy  $E_k$  of the particle?



14. Two waves meet at a point. The waves have a path difference of  $\frac{\lambda}{4}$ . The phase difference between the waves is

- A.  $\frac{\pi}{8}$  rad.
- B.  $\frac{\pi}{4}$  rad.
- C.  $\frac{\pi}{2}$  rad.
- D.  $\pi$  rad.

15. A string vibrates with fundamental frequency  $f$ . The wavelength of the sound produced in air is  $\lambda$ . Which of the following correctly gives the frequency of vibration of the fourth harmonic of the string and the wavelength of the sound in air?

	Frequency	Wavelength
A.	$\frac{f}{2}$	$\frac{\lambda}{4}$
B.	$4f$	$4\lambda$
C.	$\frac{f}{2}$	$4\lambda$
D.	$4f$	$\frac{\lambda}{4}$

16. A radar speed gun is used to measure the speed of a car. The car is moving with speed  $v$  away from the gun.

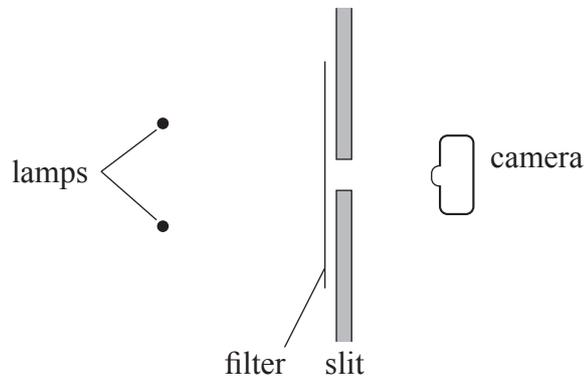


The radar emits microwaves of frequency  $f$  and speed  $c$ . Which of the following is the frequency of the microwaves measured at the gun after reflection by the car?

- A.  $f + \left(\frac{2v}{c} f\right)$
- B.  $f + \left(\frac{v}{c} f\right)$
- C.  $f - \left(\frac{2v}{c} f\right)$
- D.  $f - \left(\frac{v}{c} f\right)$

- 17. An optically active substance
  - A. completely absorbs polarized light.
  - B. unpolarizes polarized light.
  - C. polarizes unpolarized light.
  - D. rotates the plane of polarization.

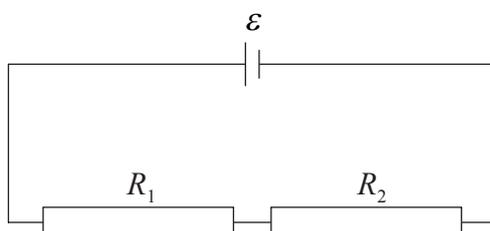
18. The diagram below shows two identical filament lamps separated by a small distance. Light from the lamps is incident on a narrow slit behind a green filter. The slit is parallel to the filament of each lamp. A photograph is taken of the lamps through the slit. The images of the filaments on the photograph are just resolved.



The green filter is replaced by a red filter and then by a violet filter. For each filter a photograph is taken of the lamps through the slit. Which of the following correctly describes the resolution of the images using a red and using a violet filter?

	<b>Red filter</b>	<b>Violet filter</b>
A.	resolved	resolved
B.	resolved	not resolved
C.	not resolved	resolved
D.	not resolved	not resolved

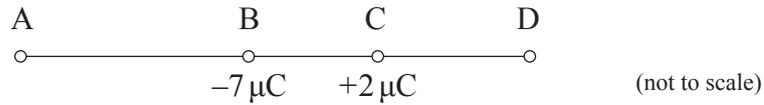
19. The definition of the ampere refers to the
- A. number of electrons passing a given point per second.
  - B. force between parallel current-carrying conductors.
  - C. power dissipated per unit resistance.
  - D. amount of charge transferred per second.
20. Two resistors, of resistance  $R_1$  and  $R_2$ , are connected in series with a cell of emf  $\varepsilon$  and negligible internal resistance.



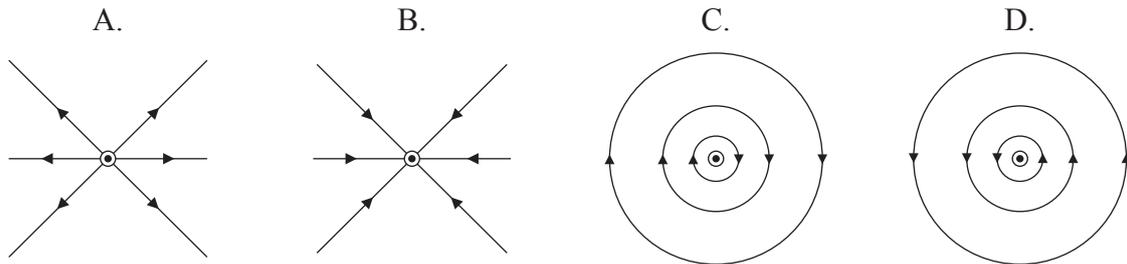
Which expression gives the potential difference across the resistor of resistance  $R_1$ ?

- A.  $\left( \frac{R_1}{R_1 + R_2} \right) \varepsilon$
- B.  $\left( \frac{R_1 + R_2}{R_1} \right) \varepsilon$
- C.  $\left( \frac{R_2}{R_1 + R_2} \right) \varepsilon$
- D.  $\left( \frac{R_1 + R_2}{R_2} \right) \varepsilon$

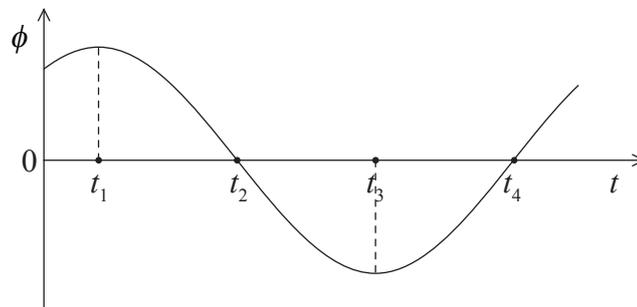
21. Two isolated point charges,  $-7\mu\text{C}$  and  $+2\mu\text{C}$ , are at a fixed distance apart. At which point is it possible for the electric field strength to be zero?



22. A long straight wire carries an electric current perpendicularly out of the paper. Which of the following represents the magnetic field pattern due to the current?



23. The graph shows the variation with time  $t$  of the magnetic flux  $\phi$  through a coil that is rotating in a uniform magnetic field.



The magnitude of the emf induced across the ends of the coil is maximum at time(s)

- A.  $t_1$  and  $t_3$ .
- B.  $t_2$  and  $t_4$ .
- C.  $t_3$  only.
- D.  $t_4$  only.

24. The rms current rating of an electric heater is 4A. What direct current would produce the same power dissipation in the electric heater?

A.  $\frac{4}{\sqrt{2}}$  A

B. 4A

C.  $4\sqrt{2}$  A

D. 8A

25. Two samples of radioactive substances X and Y have the same initial activity. The half-life of X is  $T$  and the half-life of Y is  $3T$ . After a time of  $3T$  the ratio

$$\frac{\text{activity of substance X}}{\text{activity of substance Y}}$$
 is

A. 8.

B. 4.

C.  $\frac{1}{4}$ .

D.  $\frac{1}{8}$ .

26. In a fission reaction, the total mass and the total binding energy before the reaction are  $M_i$  and  $E_i$  respectively, where the binding energy is defined as a positive quantity. After the reaction the total mass is  $M_f$  and the total binding energy is  $E_f$ . Which of the following correctly compares the total masses and the total binding energies?

	<b>Total mass</b>	<b>Total binding energy</b>
A.	$M_f > M_i$	$E_f < E_i$
B.	$M_f > M_i$	$E_f > E_i$
C.	$M_f < M_i$	$E_f < E_i$
D.	$M_f < M_i$	$E_f > E_i$

27. Monochromatic light is incident on a metal surface and electrons are released. The intensity of the incident light is increased. What changes, if any, occur in the rate of emission of electrons and the kinetic energy of the emitted electrons?

	<b>Rate of emission of electrons</b>	<b>Kinetic energy of the emitted electrons</b>
A.	increase	increase
B.	decrease	no change
C.	decrease	increase
D.	increase	no change

28. An electron is confined to move in one dimension in a box of length  $L$ . Which of the following gives the momentum of the electron in its lowest energy state?

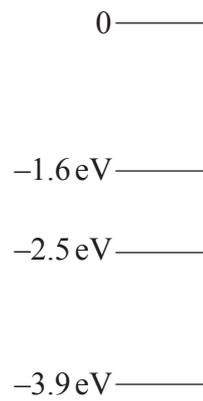
A.  $\frac{h}{4L}$

B.  $\frac{h}{2L}$

C.  $\frac{h}{L}$

D.  $\frac{2h}{L}$

29. The diagram below shows some of the energy levels available to an electron in a caesium atom.



Photons of energy 0.9 eV pass through a sample of low pressure caesium vapour. Which of the following gives the energy transition of the electron when a photon is absorbed?

- A. From -3.9 eV to 0
- B. From -2.5 eV to -1.6 eV
- C. From -1.6 eV to -2.5 eV
- D. From 0 to -3.9 eV

30. The magnitude of the uncertainty in the position of a particle is equal to the de Broglie wavelength of the particle. Which of the following is the minimum uncertainty in the momentum  $p$  of the particle?

A.  $\frac{p}{4\pi}$

B.  $\frac{4\pi}{p}$

C.  $\frac{h}{p}$

D.  $\frac{p}{h}$

31. Which of the following provides evidence for the quantization of nuclear energy levels?

I. Alpha particles have discrete values of kinetic energies

II. Gamma-ray photons have discrete energies

III. Atomic line emission spectra

A. I only

B. II only

C. I and II only

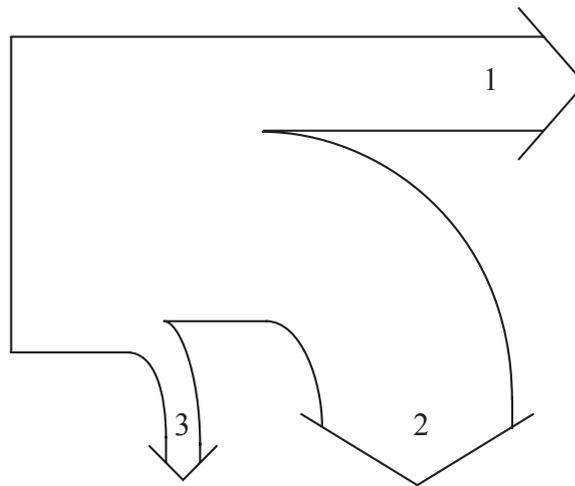
D. I, II and III

32. A radioactive substance S has a decay constant  $\lambda_S$ , substance T has a decay constant  $\lambda_T$ . Initially a sample of S contains  $N_S$  nuclei and a sample of T contains  $N_T$  nuclei. The initial activity of both samples is the same.

The ratio  $\frac{N_S}{N_T}$  is

- A. 1
- B.  $\frac{\lambda_S}{\lambda_T}$
- C.  $\frac{\lambda_T}{\lambda_S}$
- D.  $\lambda_S\lambda_T$

33. The Sankey diagram of a fossil-fuelled power station is shown below.



Which of the following best identifies the thermal energy removed by water and the useful electrical energy output of the station?

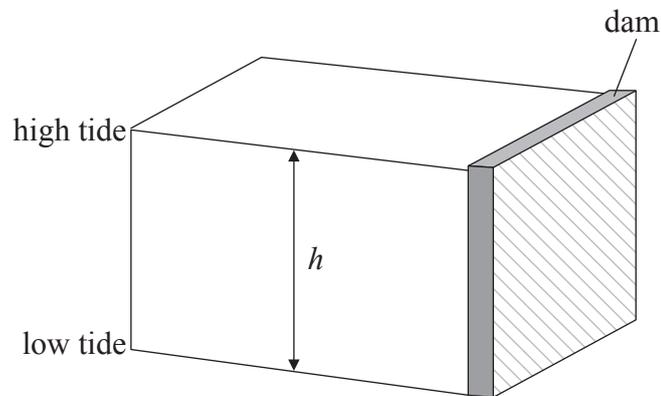
	<b>Thermal energy removed</b>	<b>Useful electrical energy output</b>
A.	2	1
B.	2	3
C.	3	1
D.	1	2

34. World energy resources include coal, nuclear fuel and geothermal energy. Which of the following lists these resources in order of energy use in the world?

- A. nuclear, geothermal, coal
- B. nuclear, coal, geothermal
- C. coal, geothermal, nuclear
- D. coal, nuclear, geothermal

35. Which of the following processes leads to the production of a nucleus of plutonium-239 from a nucleus of uranium-238?
- A. Neutron capture by uranium nucleus
  - B. Alpha decay of uranium nucleus
  - C. Electron capture by uranium nucleus
  - D. Nuclear fission of uranium nucleus

36. Water is contained in a tidal basin behind a dam. The water has a depth  $h$  at high tide and zero at low tide, as shown in the diagram.



The gravitational potential energy of the water stored in the basin between a high tide and a low tide is proportional to

- A.  $\sqrt{h}$ .
- B.  $h$ .
- C.  $h^2$ .
- D.  $h^3$ .

37. Which of the following describes the role of the atmosphere in the greenhouse effect?
- A. The atmosphere is transparent to all solar radiation.
  - B. The atmosphere absorbs infrared radiation from the ground.
  - C. The atmosphere scatters red light more than blue light.
  - D. Clouds in the atmosphere prevent absorption of infrared radiation.
38. What is the value of the binary number 11001 in decimal notation?
- A. 50
  - B. 38
  - C. 25
  - D. 19
39. A CCD camera is used to capture the image of a painting. The area of the painting is  $2.0 \text{ m}^2$  and the area of the image is  $50 \text{ mm}^2$ . Which of the following is the linear magnification of the image?
- A.  $2.5 \times 10^{-5}$
  - B.  $5.0 \times 10^{-3}$
  - C.  $2.0 \times 10^2$
  - D.  $4.0 \times 10^4$

40. An analogue signal is sampled at time intervals  $t$ . Each sample is converted to a digital number having  $n$  bits. What is the total number of bits produced in a time  $T$ ?

A.  $\frac{nT}{t}$

B.  $\frac{nt}{T}$

C.  $ntT$

D.  $\frac{n}{Tt}$

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