Diploma Programme
Programme du diplôme
Programa del Diploma

**Physics
Higher level
Paper 1**

Tuesday 31 October 2017 (afternoon)

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]**.

19 pages

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

1.   What is a correct value for the charge on an electron?

   A. 1.60×10^{-12} μC

   B. 1.60×10^{-15} mC

   C. 1.60×10^{-22} kC

   D. 1.60×10^{-24} MC

2.   The diagram shows an analogue meter with a mirror behind the pointer.
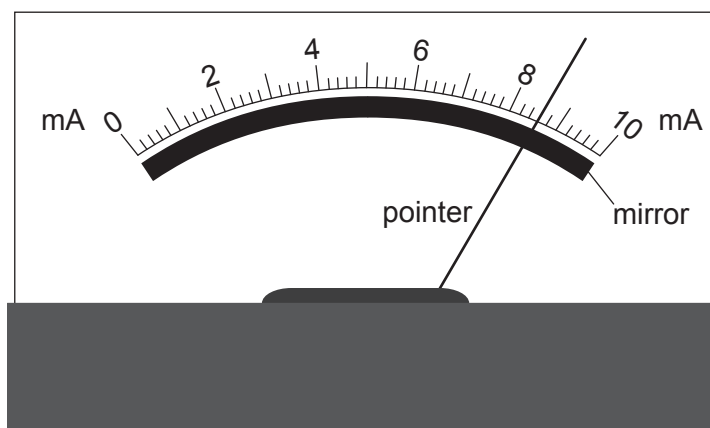
What is the main purpose of the mirror?

   A.   To provide extra light when reading the scale

   B.   To reduce the risk of parallax error when reading the scale

   C.   To enable the pointer to be seen from different angles

   D.   To magnify the image of the pointer

3.   An object is released from a stationary hot air balloon at height h above the ground.
An identical object is released at height h above the ground from another balloon that is rising
at constant speed. Air resistance is negligible. What does **not** increase for the object released
from the rising balloon?

   A.   The distance through which it falls

   B.   The time taken for it to reach the ground

   C.   The speed with which it reaches the ground

   D.   Its acceleration

4.   The diagram shows the forces acting on a block resting on an inclined plane. The angle θ is adjusted until the block is just at the point of sliding. R is the normal reaction, W the weight of the block and F the maximum frictional force.
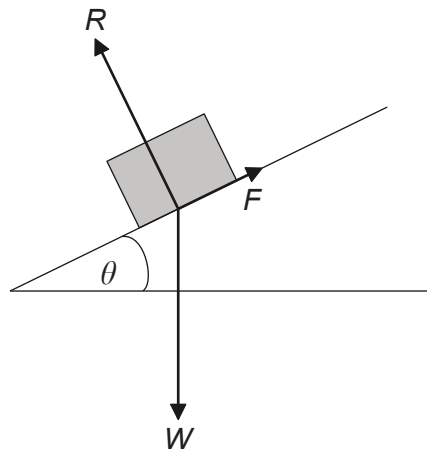

not to scale

What is the maximum coefficient of static friction between the block and the plane?

A. $\sin\theta$

B. $\cos\theta$

C. $\tan\theta$

D. $\dfrac{1}{\tan q}$

5.   A sunbather is supported in water by a floating sun bed. Which diagram represents the magnitudes of the forces acting on the sun bed?

A.

B.

C.

D.

Turn over
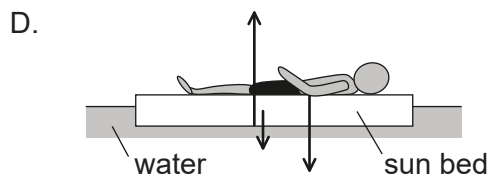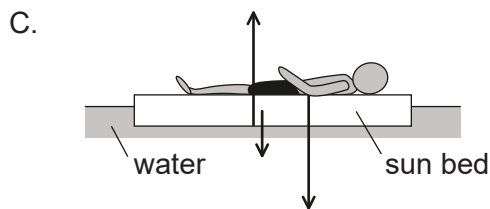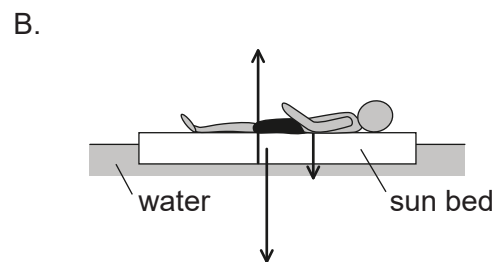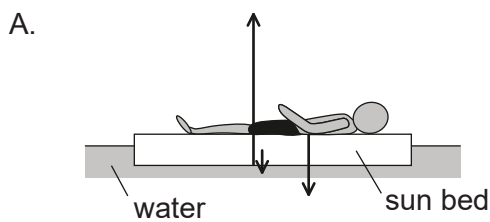
6. A system that consists of a single spring stores a total elastic potential energy E_p when a load is added to the spring. Another identical spring connected in parallel is added to the system. The same load is now applied to the parallel springs.

single spring   parallel springs
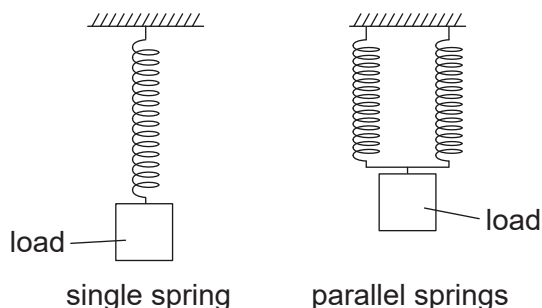
What is the total elastic potential energy stored in the changed system?

A. E_p

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

C. $\dfrac{E_p}{4}$

D. $\dfrac{E_p}{8}$

7. A toy car of mass 0.15 kg accelerates from a speed of $10\ \mathrm{cm\ s^{-1}}$ to a speed of $15\ \mathrm{cm\ s^{-1}}$. What is the impulse acting on the car?

A.   7.5 mN s

B.   37.5 mN s

C.   0.75 N s

D.   3.75 N s

8. A 1.0 kW heater supplies energy to a liquid of mass 0.50 kg. The temperature of the liquid changes by 80 K in a time of 200 s. The specific heat capacity of the liquid is $4.0\ \mathrm{kJ\ kg^{-1}\ K^{-1}}$. What is the average power lost by the liquid?

A.   0

B.   200 W

C.   800 W

D.   1600 W

9. The fraction of the internal energy that is due to molecular vibration varies in the different states of matter. What gives the order from highest fraction to lowest fraction of internal energy due to molecular vibration?

A.   liquid > gas > solid

B.   solid > liquid > gas

C.   solid > gas > liquid

D.   gas > liquid > solid

10. What does the constant n represent in the equation of state for an ideal gas $pV = nRT$?

A.   The number of atoms in the gas

B.   The number of moles of the gas

C.   The number of molecules of the gas

D.   The number of particles in the gas

11. The graph shows the variation with position s of the displacement x of a wave undergoing simple harmonic motion (SHM).
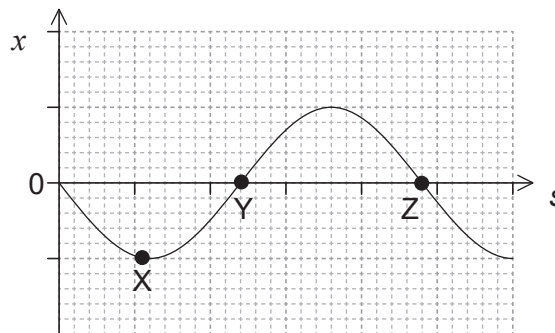
What is the magnitude of the velocity at the displacements X, Y and Z?

|	**X**	**Y**	**Z**
A.	maximum	zero	maximum
B.	zero	maximum	maximum
C.	maximum	maximum	zero
D.	zero	maximum	zero

12. Unpolarized light of intensity I_0 is incident on a polarizing filter. Light from this filter is incident on a second filter, which has its axis of polarization at 30˚ to that of the first filter.

The value of $\cos 30˚$ is $\dfrac{\sqrt{3}}{2}$. What is the intensity of the light emerging through the second filter?

A. $\dfrac{\sqrt{3}}{2} I_0$

B. $\dfrac{3}{2} I_0$

C. $\dfrac{3}{4} I_0$

D. $\dfrac{3}{8} I_0$

13. The refractive index for light travelling from medium X to medium Y is $\dfrac{4}{3}$. The refractive index for light travelling from medium Y to medium Z is $\dfrac{3}{5}$. What is the refractive index for light travelling from medium X to medium Z?

A. $\dfrac{4}{5}$

B. $\dfrac{15}{12}$

C. $\dfrac{5}{4}$

D. $\dfrac{29}{15}$

14.   The diagram shows a second harmonic standing wave on a string fixed at both ends.
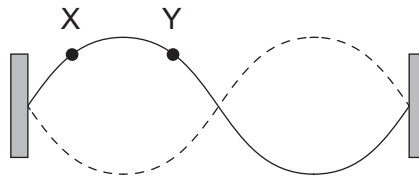
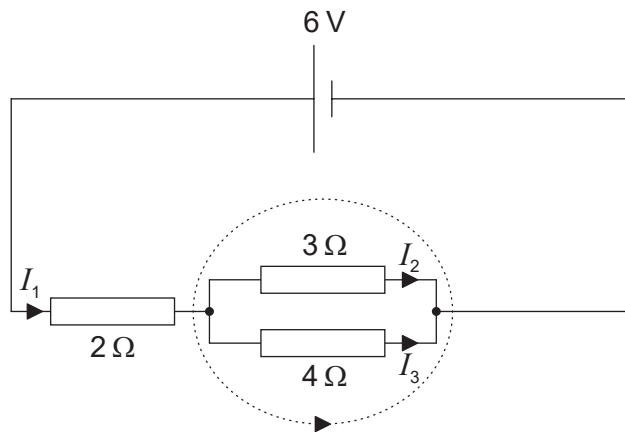
What is the phase difference, in rad, between the particle at X and the particle at Y?

A.   0

B. $\dfrac{\pi}{4}$

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

D. $\dfrac{3\pi}{4}$

15.   Two wires, X and Y, are made from the same metal. The wires are connected in series. The radius of X is twice that of Y. The carrier drift speed in X is v_X and in Y it is v_Y.

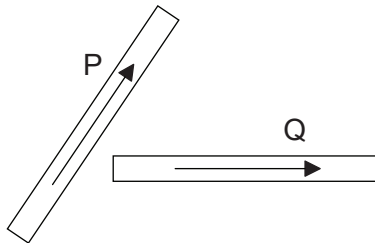What is the value of the ratio $\dfrac{v_X}{v_Y}$?

A.   0.25

B.   0.50

C.   2.00

D.   4.00

16. Kirchhoff's laws are applied to the circuit shown.

6 V


What is the equation for the dotted loop?

A. $0 = 3I_2 + 4I_3$

B. $0 = 4I_3 - 3I_2$

C. $6 = 2I_1 + 3I_2 + 4I_3$

D. $6 = 3I_2 + 4I_3$

17. The diagram shows two current-carrying wires, P and Q, that both lie in the plane of the paper. The arrows show the conventional current direction in the wires.

The electromagnetic force on Q is in the same plane as that of the wires. What is the direction of the electromagnetic force acting on Q?
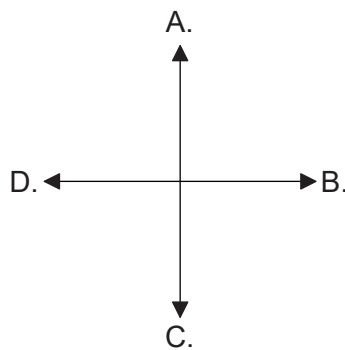
18. The diagram shows the magnetic field surrounding two current-carrying metal wires P and Q. The wires are parallel to each other and at right angles to the plane of the page.
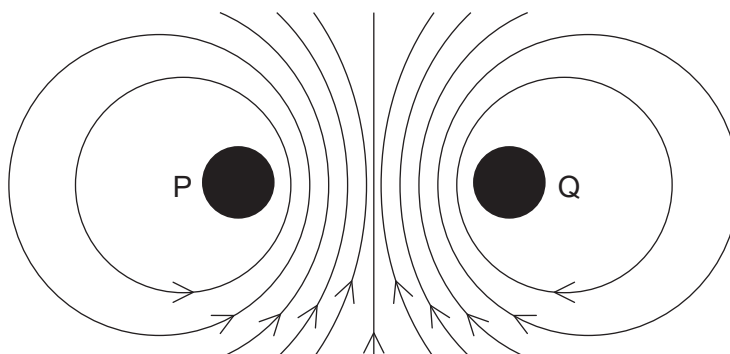
What is the direction of the electron flow in P and the direction of the electron flow in Q?

	Direction of electron flow in P	Direction of electron flow in Q
A.	into page	into page
B.	into page	out of page
C.	out of page	into page
D.	out of page	out of page

19. A satellite X of mass m orbits the Earth with a period T. What will be the orbital period of satellite Y of mass $2m$ occupying the same orbit as X?

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

B. T

C. $\sqrt{2}T$

D. $2T$

20. Which statement about atomic spectra is **not** true?

A. They provide evidence for discrete energy levels in atoms.

B. Emission and absorption lines of equal frequency correspond to transitions between the same two energy levels.

C. Absorption lines arise when electrons gain energy.

D. Emission lines always correspond to the visible part of the electromagnetic spectrum.

Turn over

21. What gives the total change in nuclear mass and the change in nuclear binding energy as a result of a nuclear fusion reaction?

|	**Nuclear mass**	**Nuclear binding energy**
A.	decreases	decreases
B.	decreases	increases
C.	increases	decreases
D.	increases	increases

22. The Feynman diagram shows a particle interaction involving a W^- boson.
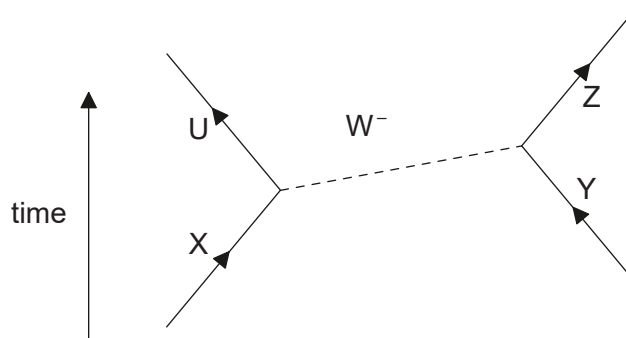
Which particles are interacting?

A.   U and Y

B. W^- boson and Y

C.   X and Y

D.   U and X

23. Samples of different radioactive nuclides have equal numbers of nuclei. Which graph shows the relationship between the half-life $t_{\frac{1}{2}}$ and the activity A for the samples?

A.

B.

C.

D.
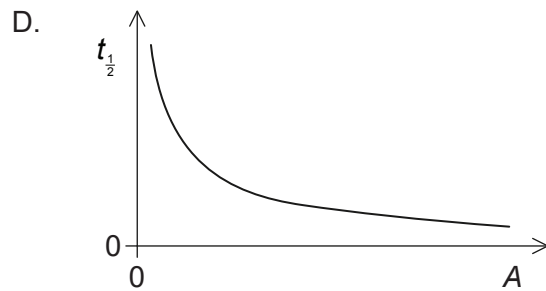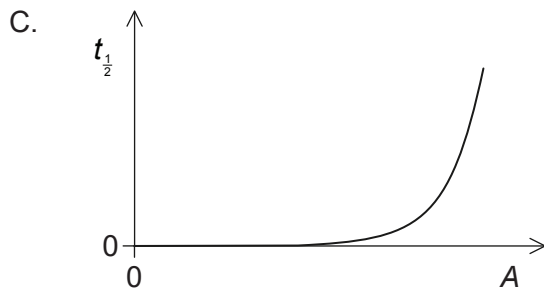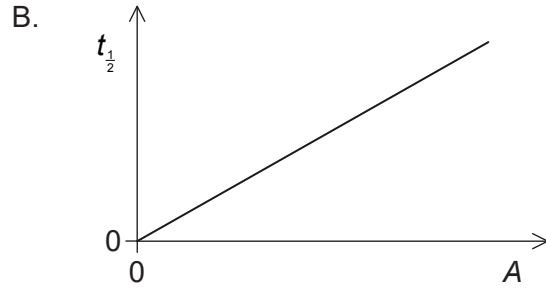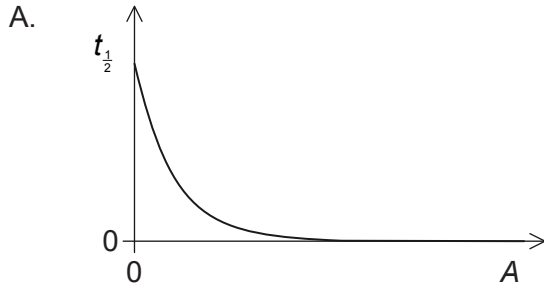
24. Which of the energy sources are classified as renewable and non-renewable?

	Renewable	**Non-renewable**
A.	Sun	wind
B.	natural gas	geothermal
C.	biomass	crude oil
D.	uranium-235	coal

25. A black body emits radiation with its greatest intensity at a wavelength of l_{max}. The surface temperature of the black body doubles without any other change occurring. What is the wavelength at which the greatest intensity of radiation is emitted?

A. l_{max}

B. $\dfrac{l_{max}}{2}$

C. $\dfrac{l_{max}}{4}$

D. $\dfrac{l_{max}}{16}$

Turn over

26. The three statements give possible reasons why an average value should be used for the solar constant.

      I.   The Sun's output varies during its 11 year cycle.

      II.   The Earth is in elliptical orbit around the Sun.

      III.   The plane of the Earth's spin on its axis is tilted to the plane of its orbit about the Sun.

Which are the correct reasons for using an average value for the solar constant?

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

27. A spring loaded with mass m oscillates with simple harmonic motion. The amplitude of the motion is A and the spring has total energy E. What is the total energy of the spring when the mass is increased to $3m$ and the amplitude is increased to $2A$?

A. $2E$

B. $4E$

C. $12E$

D. $18E$

28. Monochromatic light is incident on two identical slits to produce an interference pattern on a screen. One slit is then covered so that no light emerges from it. What is the change to the pattern observed on the screen?

A.   Fewer maxima will be observed.

B.   The intensity of the central maximum will increase.

C.   The outer maxima will become narrower.

D.   The width of the central maximum will decrease.

29. A transparent liquid forms a parallel-sided thin film in air. The diagram shows a ray I incident on the upper air–film boundary at normal incidence (the rays are shown at an angle to the normal for clarity).
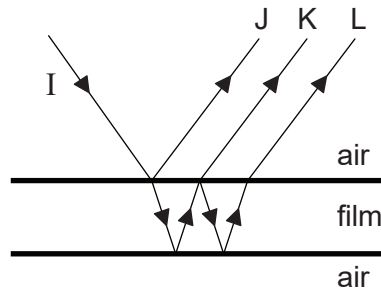
Reflections from the top and bottom surfaces of the film result in three rays J, K and L. Which of the rays has undergone a phase change of π rad?

A.   J only

B.   J and L only

C.   J and K only

D.   J, K and L

30. A stationary sound source emits waves of wavelength λ and speed v. The source now moves away from a stationary observer. What are the wavelength and speed of the sound as measured by the observer?

	Wavelength	Speed
A.	longer than λ	equal to v
B.	longer than λ	less than v
C.	shorter than λ	equal to v
D.	shorter than λ	less than v

31. A charge of -3 C is moved from A to B and then back to A. The electric potential at A is $+10$ V and the electric potential at B is -20 V. What is the work done in moving the charge from A to B and the total work done?

	Work done in moving from A to B / J	Total work done / J
A.	30	0
B.	30	60
C.	90	0
D.	90	180

32. A spacecraft moves towards the Earth under the influence of the gravitational field of the Earth. The three quantities that depend on the distance r of the spacecraft from the centre of the Earth are the

    I.   gravitational potential energy of the spacecraft

    II   gravitational field strength acting on the spacecraft

    III.   gravitational force acting on the spacecraft.

Which of the quantities are proportional to $\dfrac{1}{r^2}$?

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

33. An isolated hollow metal sphere of radius R carries a positive charge. Which graph shows the variation of potential V with distance x from the centre of the sphere?

A.

B.

C.

D.
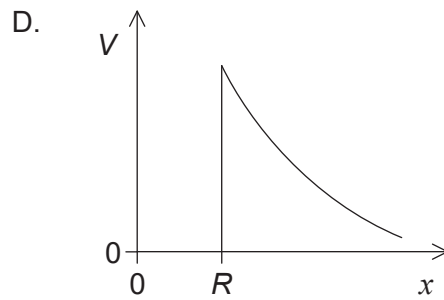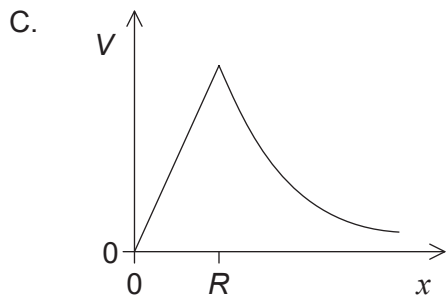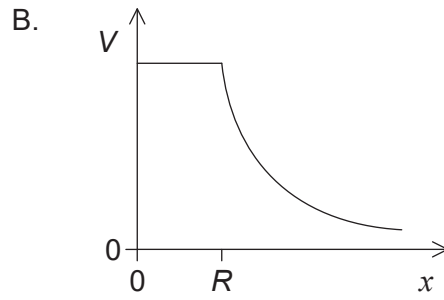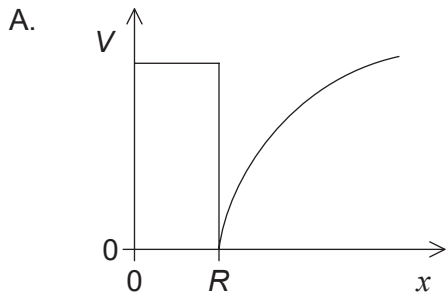
34. The plane of a coil is positioned at right angles to a magnetic field of flux density B. The coil has N turns, each of area A. The coil is rotated through $180°$ in time t.

coil of N turns and area A

B

$180°$
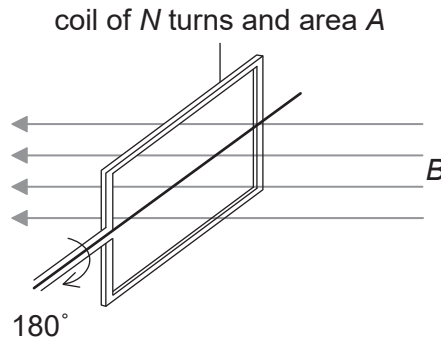
What is the magnitude of the induced emf?

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

B. $\dfrac{2BA}{t}$

C. $\dfrac{BAN}{t}$

D. $\dfrac{2BAN}{t}$

35. The ratio $\dfrac{\text{number of primary turns}}{\text{number of secondary turns}}$ for a transformer is 2.5.

The primary coil of the transformer draws a current of 0.25 A from a 200 V alternating current (ac) supply. The current in the secondary coil is 0.5 A. What is the efficiency of the transformer?

A.   20 %

B.   50 %

C.   80 %

D.   100 %

36. An alternating current (ac) generator produces a peak emf E_0 and periodic time T. What are the peak emf and periodic time when the frequency of rotation is doubled?

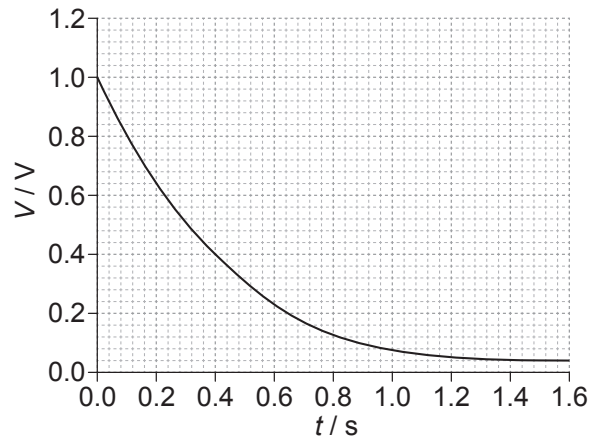|	Peak emf	Periodic time
A.	$2E_0$	$2T$
B.	$2E_0$	$\dfrac{T}{2}$
C.	E_0	$2T$
D.	E_0	$\dfrac{T}{2}$

**37.** Six identical capacitors, each of value *C*, are connected as shown.
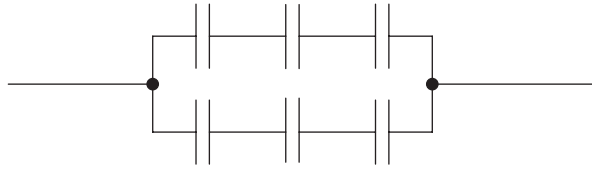

What is the total capacitance?

A. $\dfrac{C}{6}$

B. $\dfrac{2C}{3}$

C. $\dfrac{3C}{2}$

D. $6C$

38. A capacitor of capacitance C discharges through a resistor of resistance R. The graph shows the variation with time t of the voltage V across the capacitor.

The capacitor is changed to one of value $2C$ and the resistor is changed to one of value $2R$. Which graph shows the variation with t of V when the new combination is discharged?

A.

B.

C.

D.
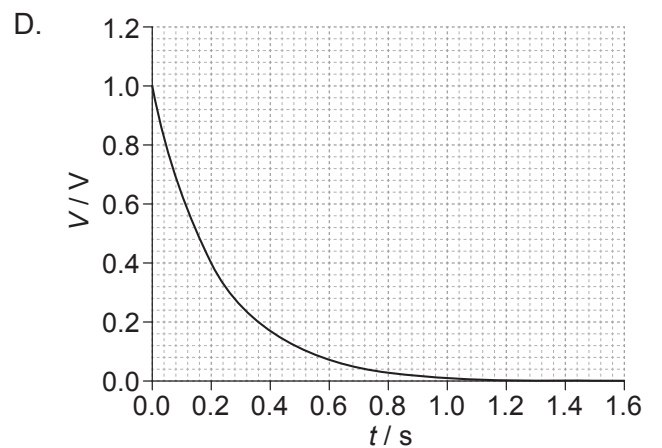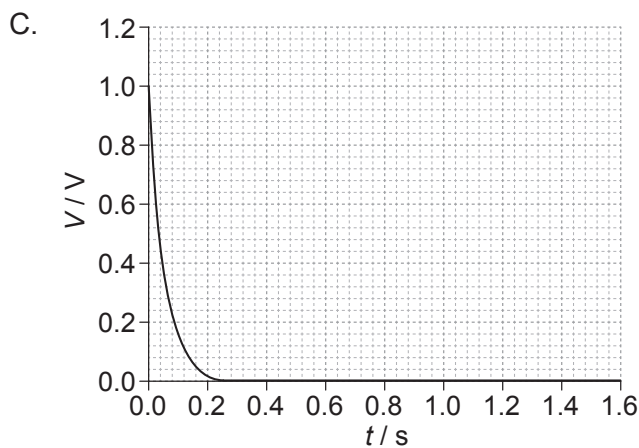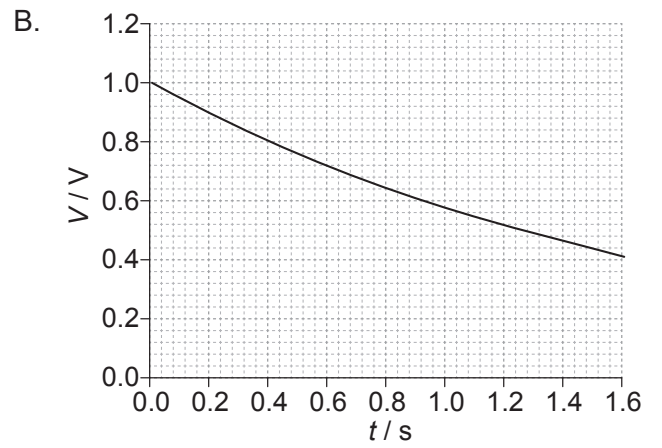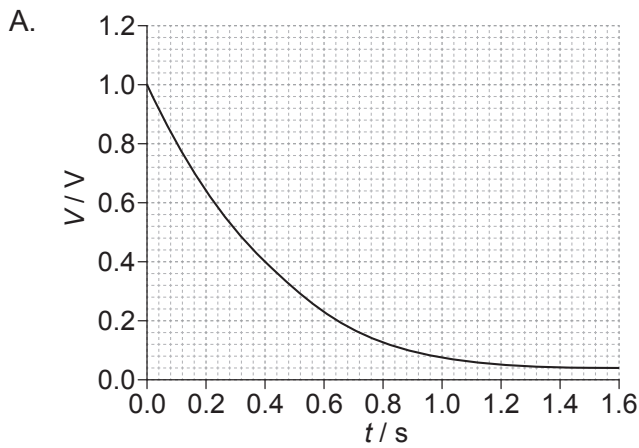
39. Monochromatic electromagnetic radiation is incident on a metal surface. The kinetic energy of the electrons released from the metal

A.   is constant because the photons have a constant energy.

B.   is constant because the metal has a constant work function.

C.   varies because the electrons are not equally bound to the metal lattice.

D.   varies because the work function of the metal is different for different electrons.

40. A photon interacts with a nearby nucleus to produce an electron. What is the name of this process?

A.   Pair annihilation

B.   Pair production

C.   Electron diffraction

D.   Quantum tunnelling