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**PHYSICS
HIGHER LEVEL
PAPER 1**

Thursday 6 November 2014 (morning)

1 hour

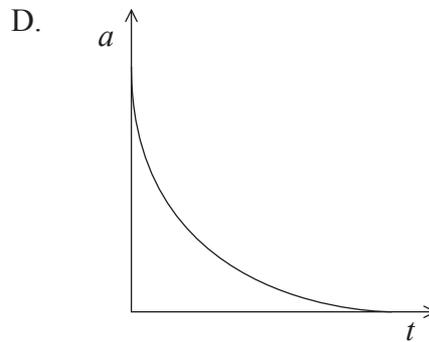
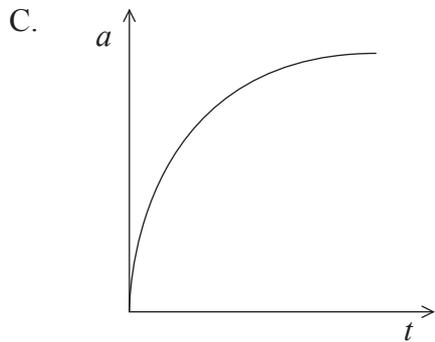
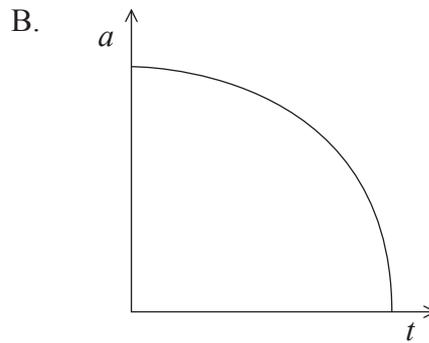
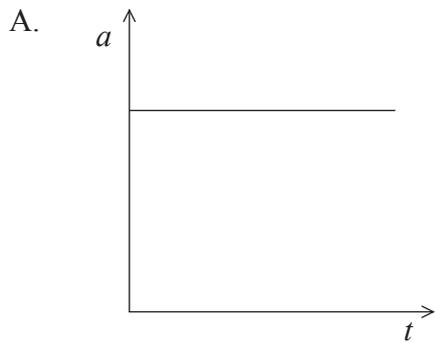
INSTRUCTIONS TO CANDIDATES

- 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. What is the unit for surface heat capacity?

- A. $\text{Nm}^{-2}\text{K}^{-1}$
- B. $\text{kgms}^{-2}\text{K}^{-1}$
- C. $\text{kg s}^{-2}\text{K}^{-1}$
- D. $\text{Nm}^{-3}\text{K}^{-1}$

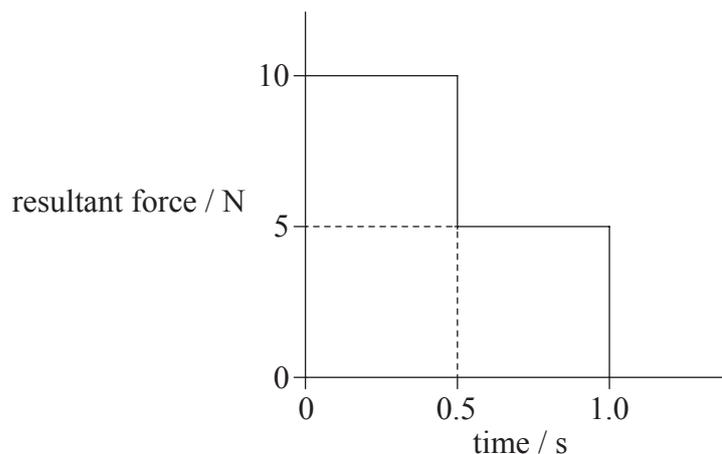
2. An object is dropped from rest above the Earth's surface. Air resistance acts on the object. What is the variation of acceleration a with time t for the object?



3. Which of the following is a condition for an object to be in translational equilibrium?

- A. The object must be moving at constant speed.
- B. The velocity of the object in any direction must be zero.
- C. The forces acting horizontally on the object must equal the forces acting vertically on the object.
- D. The resultant force acting on the object must be zero.

4. The resultant force acting on an object of mass 5.0 kg varies with time as shown. The object is initially at rest.



What is the speed of the object after 1.0 s?

- A. 0.50 ms^{-1}
 B. 1.0 ms^{-1}
 C. 1.5 ms^{-1}
 D. 2.0 ms^{-1}
5. An object rotates in a horizontal circle when acted on by a centripetal force F . What is the centripetal force acting on the object when the radius of the circle doubles and the kinetic energy of the object halves?
- A. $\frac{F}{4}$
 B. $\frac{F}{2}$
 C. F
 D. $4F$

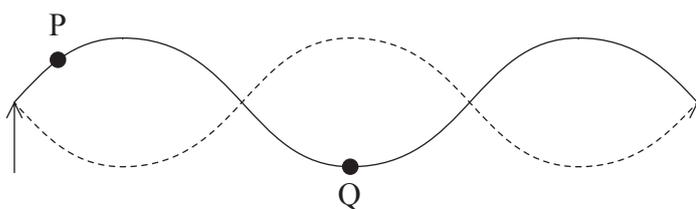
6. Two objects are in thermal contact, initially at different temperatures. Which of the following determines the transfer of thermal energy between the objects?
- I. The mass of each object
 - II. The thermal capacity of the objects
 - III. The temperature of the objects
- A. I only
 - B. I and II only
 - C. II and III only
 - D. III only
7. An electrical heating coil of power P is used to transfer thermal energy to a body of mass m . In a time t the body changes temperature by $\Delta\theta$. What is the thermal capacity of the body?
- A. $\frac{Pt}{m\Delta\theta}$
 - B. $\frac{P}{tm\Delta\theta}$
 - C. $\frac{Pt}{\Delta\theta}$
 - D. $\frac{P}{t\Delta\theta}$
8. What are the conditions of temperature and pressure at which the behaviour of a real gas approximates to the behaviour of an ideal gas?
- A. Low pressure and low temperature
 - B. Low pressure and high temperature
 - C. High pressure and low temperature
 - D. High pressure and high temperature

9. Which of the following can be deduced from the second law of thermodynamics?
- A. Thermal energy cannot spontaneously transfer from a low temperature region to a high temperature region.
 - B. Thermal energy cannot spontaneously transfer from a high temperature region to a low temperature region.
 - C. The entropy of an isolated system always decreases with time.
 - D. The entropy of an isolated system is the measure of the internal energy of the system.
10. A body moves with simple harmonic motion (SHM) with period T and total energy E_T . What is the total energy when the period of the motion is changed to $5T$ and the amplitude of the motion remains constant?
- A. $0.04 E_T$
 - B. $0.2 E_T$
 - C. $5 E_T$
 - D. $25 E_T$
11. The natural frequency of vibration of a system
- A. is the frequency at which it oscillates when it is driven by another system.
 - B. is the frequency at which it oscillates when it is **not** driven by another system.
 - C. depends on the damping in the system.
 - D. depends on the amplitude of the oscillation of the system.

12. X and Y are two sources of waves with identical amplitudes and frequencies. Waves from X and Y interfere constructively at a detector after travelling the same distance from source to detector.

At the detector, the ratio $\frac{\text{intensity of the resultant of the two waves}}{\text{intensity of one wave alone}}$ is

- A. $\frac{1}{2}$
 B. 1.
 C. 2.
 D. 4.
13. A string is made to vibrate at its third harmonic. The diagram shows two points P and Q at a particular instant in time.



Which of the following compares the period of vibration of P and Q and the average speed of P and Q?

	Period of vibration of P and Q	Average speed of P and Q
A.	same	same
B.	same	different
C.	different	same
D.	different	different

14. A source of sound moves away from an observer. The observed frequency of the sound differs from the frequency emitted by the source because the
- A. observed wavelength of the sound is less than the emitted wavelength.
 - B. observed wavelength of the sound is greater than the emitted wavelength.
 - C. speed of sound relative to the observer has decreased.
 - D. speed of sound relative to the observer has increased.
15. The purpose of the liquid crystal in a liquid crystal display (LCD) is to
- A. act as a low electrical resistance between the electrodes.
 - B. rotate the plane of polarization of the light passing through it.
 - C. change colour to display a segment when charge flows through it.
 - D. emit light unless charge is flowing through it.
16. Radiation is incident on a single rectangular slit. The diffracted beam that emerges from the slit is incident on a screen. The slit width is then doubled and the wavelength of the radiation is also doubled. The intensity of the radiation remains the same.

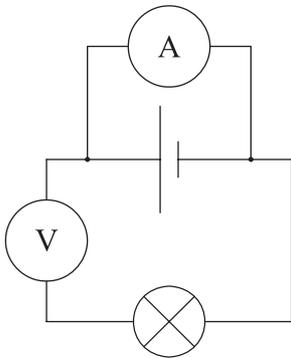
Which of the following correctly describes the angular width of the central maximum of the diffracted beam and the total number of photons incident every second on the screen?

	Angular width of the central maximum	Number of photons incident every second on the screen
A.	unchanged	unchanged
B.	changed	unchanged
C.	unchanged	changed
D.	changed	changed

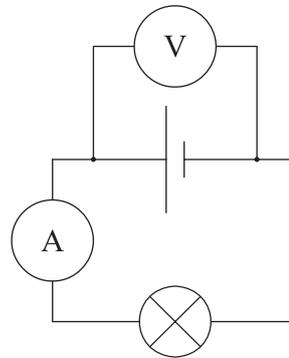
17. What will increase the resolution of an electron microscope?
- A. Increasing the accelerating voltage to decrease the electron wavelength
 - B. Increasing the accelerating voltage to increase the electron wavelength
 - C. Decreasing the accelerating voltage to decrease the electron wavelength
 - D. Decreasing the accelerating voltage to increase the electron wavelength

18. A lamp is connected to an electric cell and it lights at its working voltage. The lamp is then connected to the same cell in a circuit with an ideal ammeter and an ideal voltmeter. Which circuit allows the lamp to light at the original brightness?

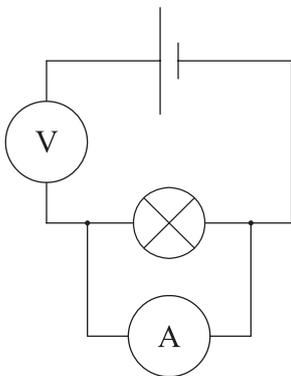
A.



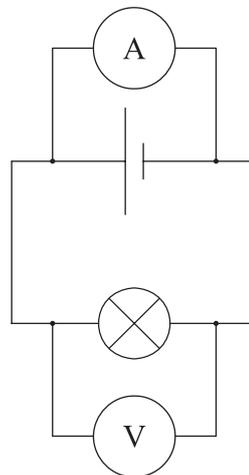
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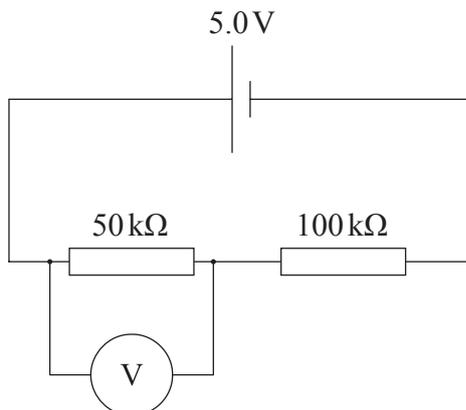
C.



D.



19. A voltmeter of resistance $50\text{ k}\Omega$ is used to measure the electric potential difference in a circuit, as shown. The cell has an electromotive force (emf) of 5.0 V and negligible internal resistance.



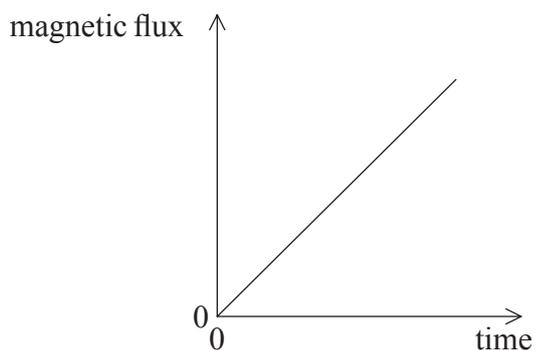
What is the reading on the voltmeter?

- A. 1.0 V
 - B. 1.7 V
 - C. 4.0 V
 - D. 5.0 V
20. A flat coil with N turns has a cross-sectional area A . The coil has a flux density of B in a direction of 90° to the plane of the coil.

What is the magnetic flux linkage?

- A. 0
- B. BA
- C. NB
- D. NBA

21. The graph shows the variation with time of a magnetic flux passing through a loop of wire.



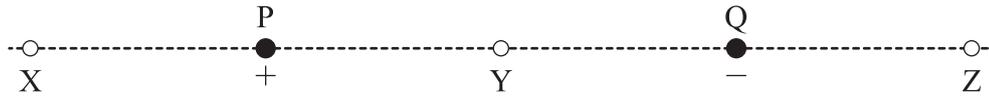
What is the magnitude of the emf induced in the coil?

- A. The area between the graph and the time axis
 - B. The area between the graph and the magnetic flux axis
 - C. The gradient of the graph
 - D. The inverse of the gradient of the graph
22. Planet X has mass M and radius R . Planet Y has mass $10M$ and radius $5R$.

What is the ratio $\frac{\text{gravitational field strength at the surface of planet X}}{\text{gravitational field strength at the surface of planet Y}}$?

- A. 0.4
- B. 0.5
- C. 2.0
- D. 2.5

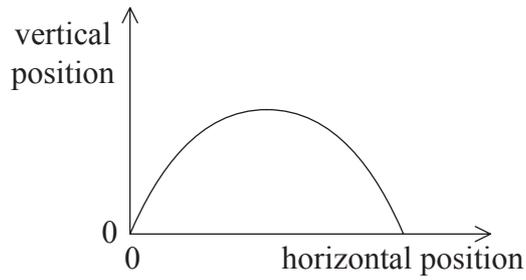
23. A positive point charge P and a negative point charge Q of equal magnitude are held at fixed positions. Y is a point midway between P and Q.



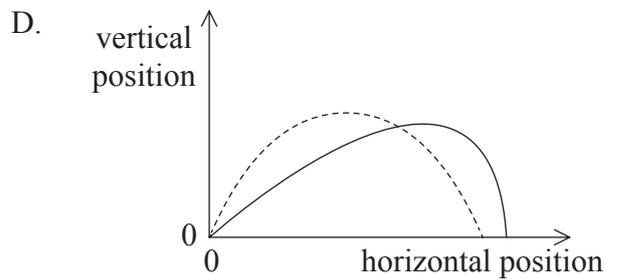
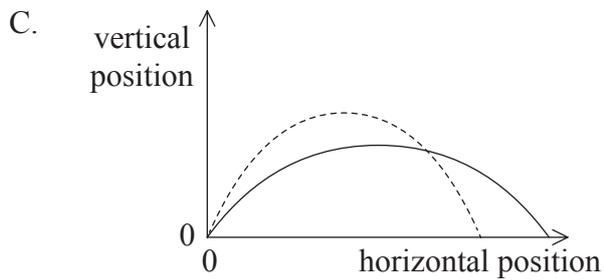
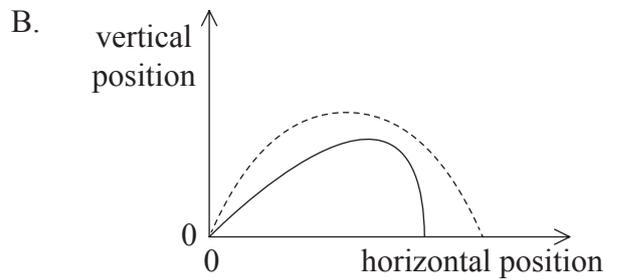
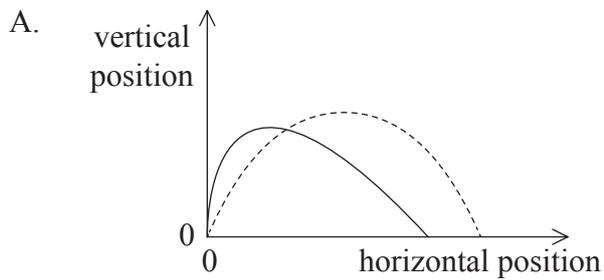
Which of the following gives the direction of the electric field due to the charges at X, Y and Z?

	X	Y	Z
A.	to right	to left	to right
B.	to right	to right	to left
C.	to left	to right	to right
D.	to left	to right	to left

24. The diagram shows the trajectory of an object projected in the absence of air resistance.



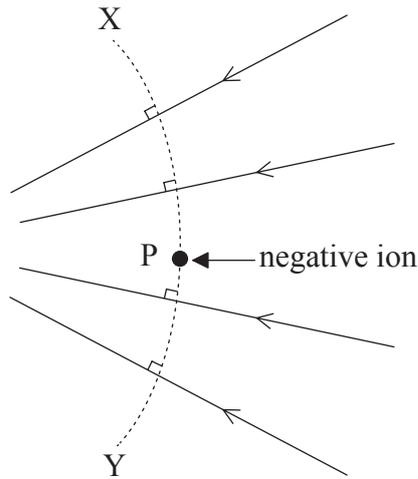
The object is then projected with the same initial conditions but air resistance is taken into account. Which of the following is the trajectory when air resistance is taken into account? The original trajectory is shown as a dotted line.



25. At the surface of a planet of radius r , the gravitational field strength is g and the gravitational potential is V . Which gives the gravitational field strength and gravitational potential at a height $3r$ above the surface?

	Gravitational field strength	Gravitational potential
A.	$\frac{g}{16}$	$\frac{V}{4}$
B.	$\frac{g}{3}$	$\frac{V}{3}$
C.	$\frac{g}{4}$	$\frac{V}{4}$
D.	$\frac{g}{9}$	$\frac{V}{3}$

26. A negative ion is held at point P in an electric field as represented by the arrowed field lines.



Which of the following describes the effect on the negative ion when it is displaced in a particular direction?

	Direction of displacement	Effect on the negative ion
A.	to the left	magnitude of electric force on the ion is unchanged
B.	to the right	potential energy of ion increases
C.	along XY towards X	potential energy of ion increases
D.	along XY towards Y	magnitude of electric force on the ion is unchanged

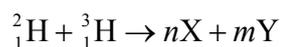
27. Three types of radiation emitted from radioactive materials are given below.

- I. Alpha
- II. Beta
- III. Gamma

Which type(s) of radiation has/have a discrete energy when emitted from radioactive materials?

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

28. A student suggests the following nuclear reaction between deuterium ${}^2_1\text{H}$ and tritium ${}^3_1\text{H}$



where n and m are integers. What are X and Y?

	X	Y
A.	electron	neutron
B.	electron	proton
C.	alpha particle	neutron
D.	alpha particle	proton

29. Which of the following is correct for the de Broglie wavelength λ of a particle when the kinetic energy of the particle is E_k ?

A. $\lambda \propto \frac{1}{E_k}$

B. $\lambda \propto \frac{1}{\sqrt{E_k}}$

C. $\lambda \propto E_k$

D. $\lambda \propto E_k^2$

30. According to the “electron in a box” model, what is the maximum wavelength of the de Broglie wave associated with an electron confined in a box of length L ?

A. $\frac{L}{2}$

B. L

C. $2L$

D. $4L$

31. According to the Heisenberg uncertainty principle, conjugate quantities are pairs of quantities that cannot be known precisely for the same object at the same time. What is the unit when two conjugate quantities are multiplied together?

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

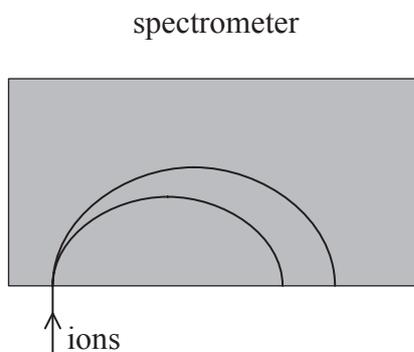
32. Three phenomena associated with nuclear and quantum physics are

- I. Einstein photoelectric effect
- II. de Broglie hypothesis
- III. Rutherford alpha particle scattering.

Which of the phenomena can be verified by firing electrons at a metal surface?

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

33. In a Bainbridge mass spectrometer, fields that contribute to the forces acting on the moving ions are
- I. electric
 - II. gravitational
 - III. magnetic.



Which field(s) is/are responsible for the curved shape of the ion paths in the shaded region of the spectrometer?

- A. I only
 - B. I and III only
 - C. II only
 - D. III only
34. A radioactive nuclide decays to a stable daughter nuclide. Initially the sample consists entirely of atoms of the radioactive nuclide. What fraction of the sample consists of the daughter nuclide after four half-lives?
- A. $\frac{15}{16}$
 - B. $\frac{1}{16}$
 - C. $\frac{1}{8}$
 - D. $\frac{7}{8}$

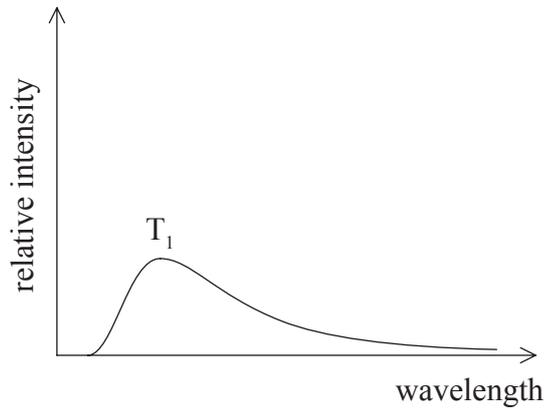
35. Which of the following is **true** when thermal energy is converted into work in a single process and a cyclical process?

	Single process	Cyclical process
A.	complete conversion of thermal energy into work can occur	energy must be transferred from the system
B.	complete conversion of thermal energy into work can never occur	energy must be transferred from the system
C.	complete conversion of thermal energy into work can occur	energy need not be transferred from the system
D.	complete conversion of thermal energy into work can never occur	energy need not be transferred from the system

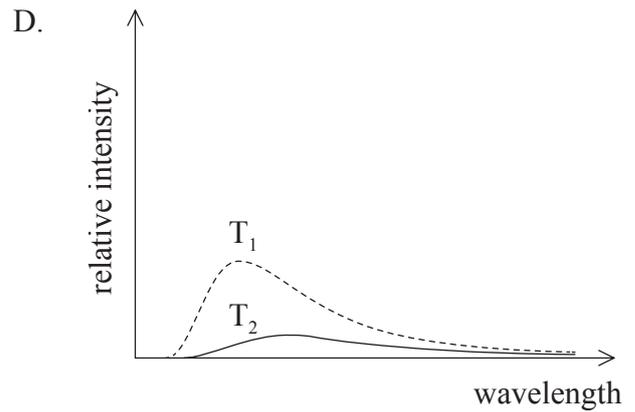
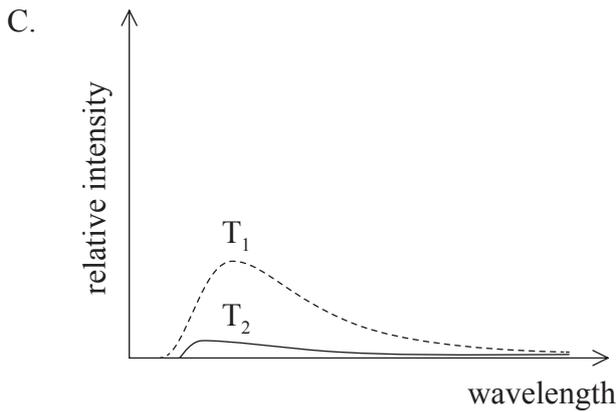
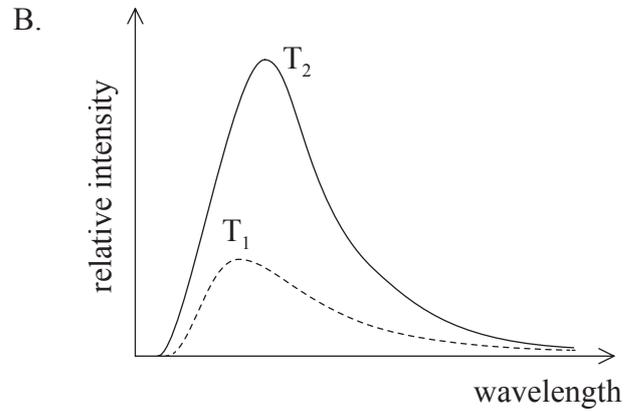
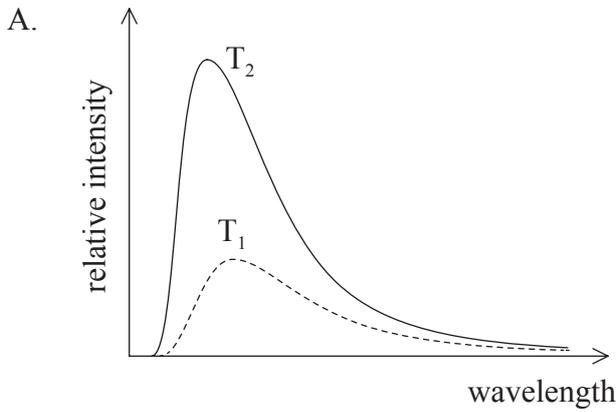
36. Changes in the climate are leading to a reduction in ice cover on Earth. Which of the following describes, for Earth, the change in albedo and the change in the rate of energy absorption?

	Change in albedo	Change in rate of energy absorption
A.	decrease	decrease
B.	decrease	increase
C.	increase	increase
D.	increase	decrease

37. The graph shows the emission spectrum for a black body at absolute temperature T_1 .



Which graph shows the emission spectrum for the same black body at an absolute temperature T_2 where $T_2 > T_1$? The original graph is shown as a dotted line.



38. The coefficient of volume expansion for sea water is γ . What is the fractional change in the depth of the ocean when its temperature changes by 1 K and its area remains constant?
- A. $\frac{\gamma}{3}$
 - B. γ
 - C. 3γ
 - D. $\sqrt[3]{\gamma}$
39. What is the equivalent binary number to the decimal number 7?
- A. 1110
 - B. 0101
 - C. 0111
 - D. 1001
40. What is the charge stored on the pixel of a charge-coupled device (CCD)?
- A. $\frac{\text{Potential difference across the pixel}}{\text{Capacitance of the pixel}}$
 - B. Potential difference across the pixel \times Capacitance of the pixel
 - C. $\frac{\text{Energy stored in the pixel}}{\text{Capacitance of the pixel}}$
 - D. Energy stored in the pixel \times Capacitance of the pixel
-