**Properties of seawater Markscheme – December 2019**

1. M18 P1 9(a) [3 max]

a. water is a polar molecule composed of 1 oxygen and 2 hydrogen «atoms»

OR

polar «covalent» bonds within water molecule lead to hydrogen bonding

OR

«in a water molecule» O atom is slightly negative and H atom is slightly positive,

therefore hydrogen bonds form between H and O atoms of different molecules

OR

a difference in electronegativity between oxygen and hydrogen leads to polar

covalent bonds within the water molecule and allows hydrogen-bonding between

other polar molecules to occur;

b. water molecules stick to each other/other polar molecules allow cohesion/adhesion

OR water has a high surface tension because of the hydrogen bonding between the

molecules

c. high specific heat/heat capacity yielding thermal stability/water helps stabilize

temperature

OR the amount of heat/energy required to change the temperature of water is greater

«because of the hydrogen bonds between the molecules»

d. high heat of evaporation therefore water assists cooling

OR the amount of heat/energy required to evaporation water/change phase/is greater «because of the hydrogen bonds between the molecules»

OR water has a high boiling point/melting point

e. ice floats/solid water is less dense than liquid water

OR molecules in solid water form a pattern «lattice of hydrogen bonds» that make it less dense than liquid «water»

f. water is a good solvent for ionic/polar solutes (OWTTE)

g. the partial charges «of water» attract ions/polar solutes forming a sphere of hydration/allowing them to be separated

*Answer must include description of water structure, otherwise [2 max]*

*Answer must include a description of how the structure of water is linked to the properties of water, otherwise [3 max]*

*Allow examples to illustrate any of the marking points*

2. a) 3.98 / 4 oC [1]

b) ice is less dense than liquid water / fewer water molecules per unit volume;

distance between water molecules is greater in ice due to hydrogen bonds; [2 max]

3. cold water is more dense than warm water; [3 max]

salty water is more dense than fresh water;

increased pressure leads to increased density.

4. (a) temperature change: 0 (units not required) [2]

heat energy: 5400

(b) latent heat of fusion/phase change/change state [2 max]

heat energy must break the intermolecular/hydrogen bonds to cause melting

temperature remains constant until all of the ice has melted

*high heat capacity is not acceptable instead of latent heat of fusion, as the question refers to change in state*

5. drop a CTD which measures conductivity;

measures continuously / at all depths;

expensive;

send a water sampling bottle down to 100 m to collect a sample of water and measure salinity with a salinity probe;

salinity probe is less expensive than a CTD;

will only get salinity at one depth; [4 max]

6. (a) Accept any kind of notation that shows the zone where temperature and salinity show rapid change with relatively small change in depth.

Accept the zone as indicated in the first 100-120 decibars. [1]

(b) if more dense at surface it will be unstable / lead to convection;

OR movement would occur only if more dense at the surface than at the bottom;

at the surface this water is warmer and less salty (so it is less dense)

(because it is less dense at the surface) it is stable / the water will not move; [2]

7. sea surface salinity is greatest at Tropics of Cancer and Capricorn / 23oN and 23oS;

salinity decreases moving from away from Tropics to the equator and to poles;

increased temperature / insolation at low latitudes / tropics leads to evaporation and consequently higher salinity;

precipitation at the equator leads to a decrease in salinity;

less evaporation at the poles means lower salinity; [3 max]

8. Chloride, Sodium, Sulfate, Magnesium, Calcium, Potassium [3 max]

9. a) fossil fuel combustion results in more carbon dioxide in the atmosphere;

carbon dioxide diffuses into the ocean;

carbon dioxide and water combine to make carbonic acid then bicarbonate and hydrogen ions which decrease the ocean pH; [2 max]

b) water in polar oceans / high latitudes is colder than at low latitudes;

cold water holds more dissolved gas / CO2 than warm water [2]

c) dissolution of shells & skeletons of pteropods / many marine organisms;

devastating effects on marine food webs as phytoplankton are affected / food sources disappearing;

corals damaged and consequently most diverse marine ecosystem is threatened;

any other reasonable impact; [3 max]

d) reduce fossil fuel combustion / alternate energy sources;

plant trees;

iron fertilization of ocean to stimulate phytoplankton productivity;

marine protected areas to help with ocean’s resilience;

*any other reasonable solution* [3 max]

10. off-gassing of volcanic rocks

comets [2 max]